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SAE JOURNAL PUBLICATION OFFICE
56th & Chestnut Sts.
Philadelphia 39, Pa.

EDITORIAL OFFICE
29 West 39th St.
New York 18, N. Y.
Tel.: Longacre 5-7174

ADVERTISING OFFICES
E. L. Carroll
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808 New Center Building
Tel.: Madison 7495
R. C. Sackett, Staff Rep.

SAE WEST COAST BRANCH
Petroleum Bldg.
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Los Angeles 15, Calif.
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Frudden Says: DUES INCREASE Being Studied

PLANS to increase SAE dues are under consideration by the Council, SAE's 1947 President C. E. Frudden revealed to members at the 1948 Annual Meeting.

"Price inflation is mainly responsible for looking toward an increase in dues," Frudden said, but emphasized that to maintain the Society's present stability in the future there is need to increase the proportion of SAE income from this relatively stable source as compared to the highly volatile source of advertising revenue.

The current SAE budget, he pointed out, provides for an approximate break-even, after important expense reductions. Other sources of SAE income have already been expanded, he said, adding that studies looking to further income from other-than-dues sources indicate the possibilities to be limited.

Basis for the Council action, Frudden explained, lies in the following memorandum presented by the Executive Committee to the Dec. 12 meeting of the Council:

"Despite the fact that the nation has been operating at the highest levels of industrial production in peacetime history during the last two years, the Society has reported deficits in both of these years. Its budget for the current year provides for an approximate break-even, achieved after a reduction in expenses of $100,000 from the amount originally provided in the 1947 budget.

Inflation Mainly Responsible

"Price inflation is mainly responsible for this situation. At prewar price levels or even at 1945 price levels, current gross income would yield a very substantial net income. One of the permanent after-effects of a great war seems to be a permanent rise in prices; hence, it appears that the Society will have to adjust itself to these higher cost levels.

"The Executive Committee believes that during a period of high industrial productivity such as the present it is unsound for the Society to operate at a deficit or on an approximate break-even basis. Rather, the committee feels that under such conditions the Society should be operating at a substantial net income to provide reserves to assure

By C. E. FRUDDEN

SAE President for 1947

stability of operation through periods of recession.

"The two main components of Society income are advertising, and dues and fees. The former is highly volatile and unpredictable. Gross receipts from advertising before associated expenditures have varied from $257,000 in 1929, down to $74,000 in 1933; up to $392,000 in 1945, and back down to $313,000 in 1947. Income from dues and fees, on the other hand, is relatively stable and directly proportional to the number of members.

"In the interest of future stability of operations, the Executive Committee believes that steps should be taken to increase the income from this source so that the Society will be less dependent on advertising.

"The Executive Committee, therefore, recommends that the Council take action to modify existing schedules of dues and fees to produce an increase in SAE income from these sources by 25%."

Council has asked its Executive Committee to study "development of a plan to increase the Society's income by $50,000 . . . for presentation back to Council in time to make the plan completely effective by Oct. 1, 1948." Consideration is being given to the possibilities of achieving this additional revenue by increasing dues from senior grades by 25% and others by lesser amounts."

Acting during the Annual Meeting, the Council's Executive Committee asked the Membership Committee's Executive Committee for a suggested program and schedule of changed dues to carry out these objectives. Before relaying its recommendations back to Council's Executive Committee, the Membership Executive Committee will ask for comments on its proposals from every membership Committeeman throughout the country.

It is expected that some specific proposals may come before the Council itself for consideration or action at its next meeting.

ECONOMY THEME Is Rife

TECHNICAL thinking toward economy – in design, production and operation – struck through sessions on five successive days at SAE's 1948 Annual Meeting at the Book-Cadillac Hotel in Detroit, Jan. 12 to 16.

Improvement of quality without increased costs got plenty of attention as in the past, but the challenge of inflating dollars brought the strongest emphasis on actually getting the cost down in one way or another.

Car engineers talked of cheaper, smaller cars and of higher compression engines in the future – with past performance maintained in smaller, lighter engines, rather than increased performance from engines of the same size. Fleet men heard of new ways to spend less money in selecting, maintaining, and operating their vehicles. Materials problems were approached from the product-cost angle and sensitivity to current economics showed up in more than a few areas of aeronautical discussions, particularly those relating to air transport.

Attendance at the meeting almost equaled last year's all-time high, while the audience assembled to hear Author William Hazlett Upson at the annual dinner exceeded last year's record total.

Business Session

At the Business Session on Tuesday evening, Past-President James M. Crawford was presented with a Life Membership in the Society and the proposed amendments to the SAE Constitution (which appeared in full in the September, 1947, SAE Journal, pp. 65-75) were given their final reading by Constitution Committee Chairman George Delaney before submission by mail to the membership for final vote.

Dinner Speakers

Upson, writer of the famous Earthworm Tractor stories in the Saturday Evening Post, drew wholehearted laughter from his engineer listeners throughout a talk on "Ergophobia – A Study in the Correlation of Laziness with Efficiency."

He was presented by Toastmaster C. G. A. Rosen, in an introduction through which Rosen took his place alongside the speaker of the evening as one of the country's leading humorists – after Detroit Section Chairman Robert Insley had welcomed SAE to Detroit and introduced Rosen with equally felicitous wit.

Serious notes at the dinner were struck by 1948 SAE President R. J. S. Pigott in his inaugural address and by 1947 SAE President C. E. Frudden in his final talk as president.

The future shows a satisfying supply of ideas that must be pushed hard in the next few years, Pigott told the members, as he urged that makers of ground and air equipment, engine manufac-

SAE Annual Meeting Dinner Toastmaster C. G. A. Rosen, left, with William Hazlett Upson, whose expounding of "Ergophobia" will long be remembered by the record attendance in Masonic Temple, and Robert Insley, chairman of SAE Detroit Section

at Annual Meeting

SAE's new president, R. J. S. Pigott (left), being introduced to members at the business Session, Jan. 13, by C. E. Frudden, whose administration as head of the Society ended at the close of the Annual Meeting

turers and the petroleum industry continue in peacetime to solve their almost universally joint problems with common wits and common sense.

Two "fascinating joint problems" are before us now, Pigott stressed:

"With diminishing petroleum and cheap iron ore reserves," he said, "we need more performance and much more efficiency from a pound of engine. This at present means chiefly higher compression and higher octane. This problem is a natural for petroleum-automotive cooperation, because we must have such coordination between fuel and engine design as will yield the greatest possible amount of suitable gasoline. . . .

"The gas turbine is a second joint problem," he continued. "In the simple cycle, the gas turbine has only about half the efficiency of our present engines, although otherwise it has all advantages. The reason is that top temperature is limited to 1400 F, whereas the engine cycle reaches 4000 F . . . What an absorbing challenge to both automotive and petroleum industries! . . . Can we solve it in the next 10 years?"

Two good reasons why a young man might want to join SAE, Frudden cited as: (1) because it gives him a chance to enhance his individual professional standing through sharing views and widening acquaintanceship and (2) because it gives him a chance to return to the industries which he and SAE serve the benefits of cooperative engineering work.

He stressed major SAE achievements in technical committee work, emphasizing the petroleum-engine relationships which have been so constructively fostered. Future opportunity for cooperative work, he said, is much greater than in the past.

CAR Sessions Consider Lower psi Tires, Propose Fuel-Saving Ideas in Design

Based on discussions and four papers presented at two Passenger Car sessions under chairmanship of **F. F. Kishline** and **E. N. Cole**; one paper presented at one Production session, under chairmanship of Stephen Johnson, Jr. . . . "Extra Low Pressure Tires for Passenger Cars," by **W. E. Shively**, Goodyear Tire & Rubber Co.; "Application of Extra Low Pressure Tires to Passenger Cars," by **G. H. Parker** and **Edgar Shay**, Chrysler Corp., "The Efficient Production and Utilization of Motor Gasoline," by **W. M. Holaday**, Socony-Vacuum Oil Co., Inc., and "Engineering's Responsibility to Production," by **H. S. Golden**, Buick Motor Division, General Motors Corp. . . . Also includes ideas from "Do Americans Want a Small, Light Car?" by **E. R. Grace**, Grant Advertising Corp. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions

PASSENGER car engineers lent an ear both to engineering co-workers in allied fields reporting contributions to car betterment and to word from the public on what it wants in a car. They were shown:

• By a petroleum engineer that greater exploitation of fuel antiknock quality is pos-

sible through design improvements to relieve the tightening gasoline situation.

- By an advertising executive that the public wants a cheaper, even though smaller car.
- By tire specialists that newly-developed soft tires raise safety and ride-comfort levels.
- By a production engineer how his plant coordinates engineering and manufacturing operations.

Engine and Octane Needs

Engine designers had best make maximum use of the current antiknock quality in fuels, oil men advised, because octane numbers aren't going up so fast in the future. Motor Method ratings may go to 79 for regular and 86 for premium; Research Method ratings to 86 and 94 by 1952, it was indicated. But the oil men clearly feel that current engine designs don't get the best out of already available fuels.

Antiknock qualities which give most efficient performance at part throttle might better be aimed at, some thought, than designing for octane needs under the most severe operating conditions, as is usually done. One 1947 car, for example, gave knock-free performance at all speeds up to 60 mph on normal heptane (zero on the octane scale) when operated at level-road constant-speed conditions on a chassis dynamometer.

If the need for peak requirements must be met, it was suggested, some sort of dual-fuel system might be the answer. (Such a system would meter one fuel high enough in octane to satisfy peak requirements at full throttle – and a second fuel, lower in quality for cruising operation.) In fact, test work was reported as under way to develop and evaluate a commercially feasible unit to permit this economizing on high octane fuels and, at the same time, satisfy the engine's antiknock wants.

"Be cautious in complicating the car," was the warning from several sources, however, to dual-fuel system advocates. It violates our automotive engineering philosophy aimed at simplifying car operation. Public resistance to added gadgetry might be stiffer than expected.

Another way of economizing on high octane fuels without sacrificing performance is alcohol-water injection. It equals hydrocarbons as an antidetonant solution, reported a researcher, and can ease the coming octane number shortage. In tests, an 85-15 alcohol solution with 3 mm of tetraethyl lead gave a 32 octane number boost at full throttle. Price alone impedes alcohol injection adoption, said a specialist, who holds high hopes for it for the future.

Additionally, it was suggested, car engineers can curb present waste of fuel antiknock quality by: Momentary decrease in spark advance at low speeds as the car is accelerated; improvement of intake manifolding to distribute the mixture better to the cylinders; use of rich mixtures during high-power operation as with airplanes; use of a high slip coupling to prevent low engine speeds at wide-open throttle; and improved combustion chamber cooling.

Lightening the car was proposed as another fuel-economizing measure. A 20% weight increase in low-priced cars since 1931 has cut mileage per gallon 12%.

The public wants a lighter, smaller car, and most industry engineers feel they can produce it, although their price estimates varied from $300 above to $300 below present car prices. These highlights emerged from a man-on-the-street survey in 16 cities and from questioning leading car engineers on the controversial light-car issue.

Over 72% of the 1619 car drivers (in all income brackets) interviewed said they'd rather buy a smaller, lighter car than present lowest priced cars; but they didn't want a midget. Three chief reasons given were: (1) lower price, (2) lower maintenance, and (3) greater driving convenience.

Lower Price Big Factor

A car composite of what the public wants would sell for $750 to $1000, be powered by a 6-cyl 70 to 80-hp engine, giving 20 to 25 mpg, with a 65 to 80-mph top speed, and a wheelbase of 90 to 115 in.

Finance companies added their okay to such proposal, citing current high prices as sufficient justification.

Most industry engineers replying to the survey agreed it could be done. Use of magnesium and aluminum instead of steel is the big way of bringing down weight. But some felt aluminum at 24¢ per lb compared to steel at 6¢ would add $300 to the cost plus higher fabricating expense with the lighter material. One in particular saw a 1000-lb reduction in weight adding 35 to 50% to prices of currently heavier cars.

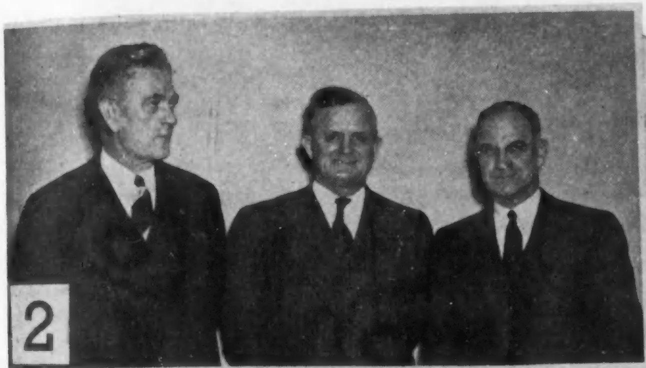
Not so, argued another engineer; it can be done for $300 below the present low price. He predicted such a car need not be a smaller one, but would weigh 2200 lb, have a 60 hp engine, 103-in. wheelbase, seat 5 people, and cost 25% less to operate and maintain.

The speaker saw significant implications in results of the light car opinion poll. Real public enthusiasm for a light car, he felt, should encourage a forward-looking car producer to build such vehicle. This challenge to automotive ingenuity will reap rich rewards for the pioneer who accepts, if the survey means anything.

Engineers in after-session discussion labeled a light car program unattractive profitwise at present. Aim of industry today, they said, is to deliver as many cars as possible to the public – and diversions such as a light-car program would disrupt present all-out manufacturing efforts. But

ANNUAL MEETING continued on page 66

Honor Guests at SAE Banquet included . . . . . .



(1) Major-Gen. Oliver P. Echols, president of the Air Industries Association of America, Inc. (center) with SAE Past-Presidents Arthur Nutt (left) and Mac Short (right)

(2) SAE Past-Presidents L. Ray Buckendale (left) and James M. Crawford (right) and W. A. Roberts, vice-president of the Tractor Division of Allis-Chalmers Mfg. Co. (center)

(3) (Left to right) Past-Presidents W. S. James and Col. H. W. Alden, Col. J. G. Vincent and Past-President H. C. Dickinson

(4) Rear-Admiral C. A. Nicholson, assistant chief for design and engineering of the U. S. Navy Bureau of Aeronautics (center) with Past-Presidents H. T. Woolson (left) and A. W. Herrington (right)

(5) (Left to right) SAE Past-Presidents D. G. Roos, Ralph R. Teetor and A. T. Colwell

(6) (Left to right) A. W. Phelps, president, Oliver Corp., C. J. Reese, president of Continental Motors Corp., and George Romney, managing director, Automobile Manufacturers Association

(7) Lovell Lawrence, Jr., president of Reaction Motors, Inc. (left) with SAE Past-President John H. Hunt

CHALLENGE t[o]

EXCERPTS FROM A PAPER* BY **ERNEST R. BREECH**

Executive Vice-President
FORD MOTOR CO.

DURING World War II practically every magazine article dealing with the postwar automotive industry pictured cars radically changed in styling and mechanical design. Actually, the automotive industry was so completely engaged in building war materials that research and development of postwar products was entirely at a standstill, as the only people who had time to think of such things were the artists who drew the pictures for the magazines, and they were not confined by engineering limitations of practicability or costs of production.

Yet, when a recent and still prospective entry into the business of manufacturing automobiles projected a car of radical design, with hydraulic drives and other innovations, many features which experienced engineers have reason to think will not work, the imagination of the public was so captured that he had no trouble selling millions of dollars worth of stock, and also sold his dealer franchises at fancy prices.

To me this is an indication that the public wants more progress and change from the automotive engineers than they have been getting during the past decade.

With one exception, we are still producing cars with conventional sliding gear transmissions, while the public is asking for automatic transmissions. This is just one example of the many improvements expected by our customers in their postwar cars.

Let us first admit that the aircraft industry has paid substantially for its engineering and research through government purchases of military aircraft, while the automotive industry has had to secure the funds for research and development from the sale of cars to the consuming public. On the other hand, the automotive industry as a whole has expended over the past 15 or 20 years, tens, if not hundreds, of millions of dollars for such development work.

When I compare the seemingly relative simplicity of the solution of some of these engineering problems in the automobile with the intricate and complicated problems which I have seen solved over the past 15 years by the aircraft industry, I wonder if the public isn't right to expect more than they are getting.

When, as a director of T. W. A., we laid out the specifications for the first Douglas DC-1 commercial air transport, a famous flier whom we had as a consultant said that no twin-engined airplane could possibly maintain altitude under full load conditions with one engine out. Still, the DC-1 took off at Albuquerque, New Mex., at an altitude of almost 5000-ft and cut one engine during the climb, under full load conditions. It continued to climb and successfully landed in Winslow, Ariz., having completed the flight on one engine in less time that the standard schedule for the equipment then in use.

It was able to do this because it was equipped with a two-position controllable-pitch propeller, which had just been developed by the Hamilton Standard Propeller Division of United Aircraft. This was soon followed by the remarkable constant speed propeller, of which there are now several

* Paper "The Challenge to Engineers," was presented at SAE Detroit Section on Oct. 6, 1947.

to Automobile Engineers

successful and different designs, which automatically set the most efficient propeller pitch for the horsepower and speed required, regardless of altitude. I might also mention the problems which had to be solved to develop the anti-icing fuel-injection carburetor, the automatic radio direction-finder, the gyro-stabilized flux-gate compass, the automatic pilot, the present reciprocating aircraft engine, weighing less than 1 lb per hp, the air-position indicator (mechanical navigator), the vast array of radio and radar devices for communication and safety of flight.

These are only some of the developments, mostly of the past decade, perfected by the aircraft engineers.

Auto Problems Simple

In the new jet-propelled airplanes, at 600 mph the air friction on the skin of the plane raises the temperature 75F. This, added to a temperature of an 80F day, gives a cockpit temperature of 155F. If any of you are amateur cooks you will know this is the temperature of medium well done beef as registered on a meat thermometer.

How is the aircraft industry solving this problem? A turbo-driven refrigeration system has been developed by bleeding the air from the turbo-compressor with very little addition to the weight of the airplane. Compare this problem from every standpoint with that of air conditioning an automobile. Compare again the problem of pressurization of an aircraft cabin with that of keeping an automobile dry inside during a heavy drain.

Every airplane being developed at the present time is so radically different from the airplane of only five years ago that it can be truly said that the designs of five years ago are completely obsolete.

One aircraft company of which I was president in the early thirties, which then was quite successful with an engineering personnel of less than 100 people, now in the depressed postwar period in the aircraft industry has more than 2400 people engaged in its research and engineering departments.

I admit that the airplane is limited primarily to commercial air transportation and military use. The problem of utility for the masses has not yet been solved. There are many reasons for this, all too numerous for comment at this time, not the least of which however is man's inherent fear of getting off the ground.

I know that I could be answered by a very brief statement from any automotive engineer as to the differences between the limitations placed on an automotive engineer and those placed on an aircraft engineer. The first answer could easily be that the aircraft engineer has not been limited by considerations of low cost of product. This must always be the first consideration of the automotive engineer. I certainly am not unmindful of that fact.

I think this is a good time to say also that in my opinion good engineering is the foundation for the success of any company. If a company does not have a well engineered product, then a good manufacturing and sales organization will not save the company. It will fail sooner or later if its product is poorly engineered. When I first came to the Ford Motor Co., this was the first major problem that we attacked. We completely reorganized our engineering department.

There is always an inherent danger in any business when it becomes prosperous and is pointed to generally as an outstanding example of progress over a period of years. There is likely to develop a smugness and feeling of self-satisfaction until one day someone awakens with a start to realize that that industry is no longer progressive. The greatest mistake that the automotive industry can make is to get into this rut. You might ask what have I to suggest. My suggestions are simple.

Young Men Needed

In the first place I think you older engineers must not only welcome whole-heartedly but must go out and seek the younger men graduating from our engineering schools, or those closeted in their own cellar laboratories who, driven on possibly by economic want, are trying to develop some new idea of locomotion, combustion, carburetion, or

Concluded on page 50

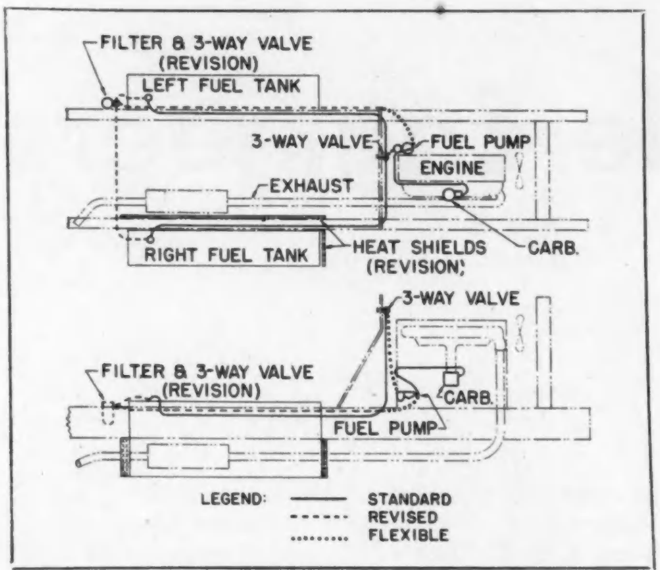


Fig. 1 – Installing heat shields are Ordnance truck fuel tanks reduced temperature rise of the fuel by 26F

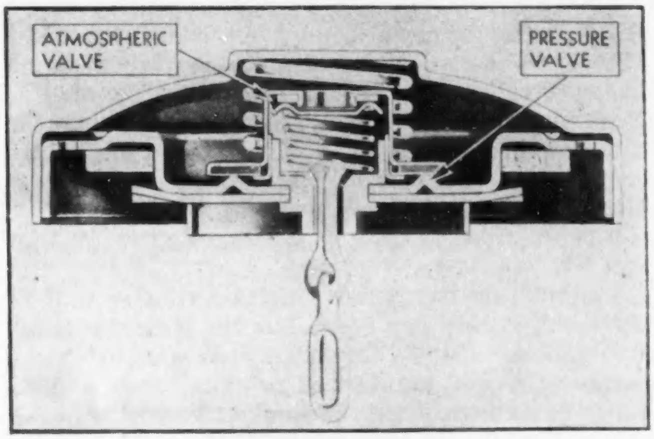


Fig. 2 – Severe vapor lock in Ordnance vehicles was remedied by this fuel tank cap. It incorporates a spring-loaded valve arrangement and makes for a self-pressurized tank

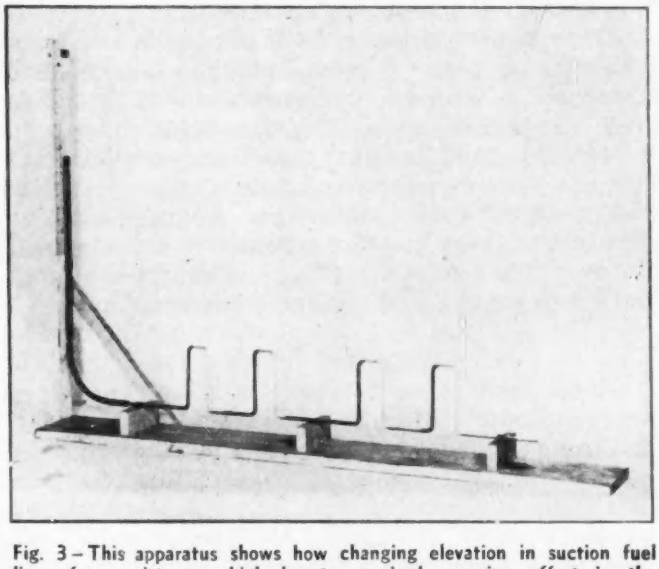


Fig. 3 – This apparatus shows how changing elevation in suction fuel lines forms airtraps which boosts required pumping effort in the presence vapors

How to Rid
VAPOR

(This paper will be published in full in SAE Quarterly Transactions)

VEHICLE fuel systems will bid farewell to vapor lock if their design – from tank filler cap to carburetor – achieves this four-point goal:

1. Fuel handling with minimum temperature rise.

2. Minimum pumping effort for tank-to-carburetor delivery.

3. Minimum fuel line elevation and cross-section changes.

4. Adequate pumping capacity to supply the carburetor with sufficient liquid fuel in the presence of large vapor volume.

Without additional cost the designer can lay out a new system or revise an existing installation satisfying these criteria. And often design simplification results. But achieving most effective results requires a realistic approach to each fuel system component.

Take the fuel tank. Big job here is to keep heat away and fuel temperature down. Locate tanks as far as possible from heat sources such as exhaust system radiation and underhood air current convection. It's the most practical way of holding down any temperature rise.

Long side tanks in commercial vehicle installations parallel to the exhaust system can be shielded from direct exhaust radiation. If necessary, the hot underhood air blast should be deflected from flowing over the tank.

Fig. 1 shows how heat shields were used in an Army Ordnance truck. Actual tests proved the shielding reduced by 26F the fuel temperature rise above ambient air after 5 hr of driving.

Raising the fuel tank where possible helps the cause by reducing suction head at the fuel pump. At the same time it reduces road surface radiation

Cars of LOCK

● BASED ON A PAPER* BY **GILBERT WAY**
Laboratory Technical Contact Representative,
Western Region,
ETHYL CORP.

● Designing a fuel system that absorbs little heat and supplies the carburetor with adequate fuel is the key to freedom from vapor lock, says Way.

● A design that toes this guiding line will pay dividends if the engineer invests a little ingenuity. Way shows how each fuel system component must be improved for satisfactory overall results.

● Fuel tank location, line size, pump design, filter installation, and carburetor heat shielding are among the items he covers in this article.

since radiant heat intensity varies inversely as the square of distance from heat source. But the fuel line from an elevated tank should drop to fuel pump level before heat exposure to minimize fuel vapor downflow.

Self-pressurized fuel tanks offer another way of alleviating vapor lock. This system, using spring-loaded valves, permits a maximum pressure buildup of about 2 psi and vents at ½ psi vacuum. The spring-loaded valving arrangement was incorporated in a fuel tank cap, shown in Fig. 2. Pressure in the fuel tank was found to aid materially Ordnance equipment under severe vapor locking conditions. In some cases the pressure cap made possible operation where without the cap the vehicle was immobile, even in lowest gear, because of vapor lock.

The pressure cap also reduces loss from weathering of hot fuel in the tank under vapor locking conditions. It reduces ordinary breathing action due to fuel temperature changes and practically eliminates weathering from this cause.

Improving Fuel Line Designs

On its journey from tank to carburetor the fuel next passes through the lines and fittings. Judgment in location and design here will cut down a goodly number of vapor lock causes.

Regarding delivery of sufficient liquid fuel, fuel line size affects flow restriction measured in terms of pressure drop. To illustrate the point, change from a 5/16-in. to a ¼-in. line would nearly quadruple the pressure drop. A ⅜-in. size gives one-third the pressure drop of a 5/16-in. line.

Coolest location for tank-to-pump fuel line in conventional front-engine vehicles is along the outside of the frame channel on the side opposite the exhaust system. Maintaining the outside location for the greatest possible distance shortens the length of line within the engine compartment. For L-head engine installations, with conventional pump drive off the camshaft front end, bringing the fuel line over the far side of the frame along the front frame cross member keeps it away from engine compartment heat.

How to Avoid Heat

To minimize heat conduction from the warm frame and to better air circulation around the line, clips should hold the fuel line slightly away from the frame rather than tightly against it. Clips should also prevent contact between cylinder block or crankcase and underhood fuel lines. If exposure to high heat is unavoidable, insulation coverings afford protection.

The ideal fuel line would be a straight length of tubing slightly sloped up from tank to pump. It would prevent counter-flow tendencies of vapor bubbles and simplify removal of vapors formed. The designer should aim toward the ideal by avoiding unnecessary rises and dips. Elevation changes of the suction fuel line increase pumping effort required when vapors form. Reason for this is the airtrap effect, demonstrated by the equipment in Fig. 3.

Another fact to remember in designing for vapor-lock-free fuel systems is that friction loss in a sharp elbow fitting is many times that of a sharp tubing bend. For example, loss in a bend

* Paper "Practical Considerations in the Design of Motor Vehicle Fuel Systems for Freedom from Vapor Lock," was presented at SAE National Fuels & Lubricants Meeting, Tulsa, Nov. 6, 1947.

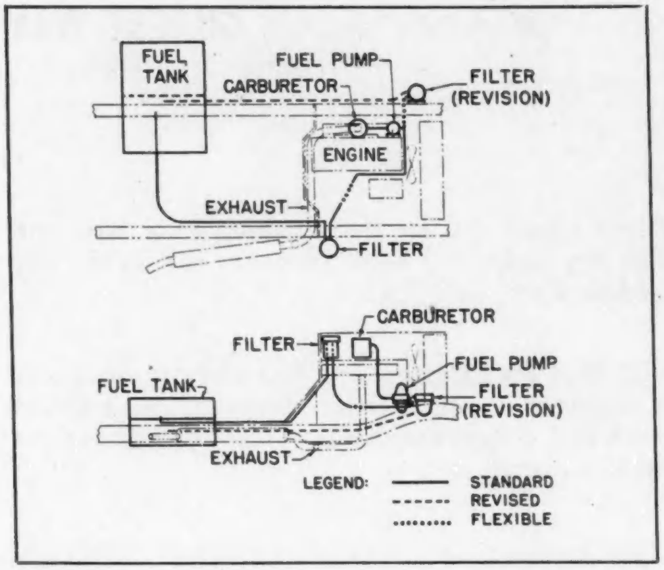


Fig. 4 – Placing an auxiliary filter at the highest point in the suction line increases vapor-forming tendencies. This diagram shows how the filter was lowered to improve the design without much sacrifice in service accessibility

with a ratio of bend-radius-to-tubing-diameter of one is one-seventh that of a 90-deg sharp elbow. This suggests use of a tubing bend and straight elbow in place of an elbow wherever possible.

Elbow elimination not only reduces restriction, it also does away with dependability of pipe thread joint tightness on final angular position of the elbow.

Electric Pump Virtues

Moving from the fuel lines to the pump, it is worthwhile noting the advantages of electric-motor-driven fuel-tank or pusher pumps. This recent development approaches the ideal because it offers these attributes of the theoretically-perfect fuel system:

1. No suction line;
2. No filter loss;
3. Positive head at pump intake;
4. Pump away from engine and exhaust system heat zone;
5. Fuel in all lines under nonpulsating pressure;
6. Elimination of changes in fuel line sections attendant with fuel filter, pump, and fittings;
7. Elimination of pressure buildup and tendency to flood carburetor during soak period;
8. Avoiding heat pickup by eliminating crankcase-mounted pump and fuel lines within engine compartment.

Desert proving ground tests showed the electric tank pump will deliver gasoline to the carburetor even if the fuel is boiling in the fuel tank. Bus and truck operators are using this pump for installations posing vapor lock problems.

Mechanically-operated diaphragm fuel pumps, practically universal on passenger cars, can handle large volumes of vapor in addition to liquid fuel. But when enough vapor forms to prevent the pump from delivering sufficient liquid to the carburetor to meet engine needs, vapor lock occurs. In borderline cases the pumping capacity can be upped by increasing pump delivery pressure and by varying the combination of diaphragm protectors. Both are simple production changes the pump manufacturer can make.

Best Filter Location

Protection of the pumping mechanism by the fuel filter on the suction side of the pump is a must; but poorly-placed auxiliary filters can aggrevate vapor locking tendencies. It's particularly unwise to locate the filter in the engine compartment where it is the highest point in the suction line. While aiming for maximum accessibility and ease of filter maintenance, this arrangement promotes vapor lock. For the suction-line installation of an auxiliary or heavy-duty fuel filter, the designer can usually find a cool spot that's reasonably accessible along the fuel line and at the same level. Fig. 4 shows a revision of this kind in a standard fuel system.

Another way to protect the pump and other parts of the fuel system is to place a submerged filter within the fuel tank. This design has many advantages over the conventional type. It virtually eliminates leakage and undesirable effects of common filters and requires practically no servicing.

Even after the fuel reaches the carburetor, excessive fuel vaporization and percolation in the carburetor bowl can make trouble. While not strictly vapor lock in the sense of failure to deliver enough fuel, these difficulties can be combated by the same approach. Excessive heat flow into the carburetor – particularly during idling or soak – can be prevented by placing a thick gasket of insulating material between carburetor and manifold flanges. The carburetor should also be insulated above the throttle body. Shielding from direct radiation or convection from the exhaust manifold will also help.

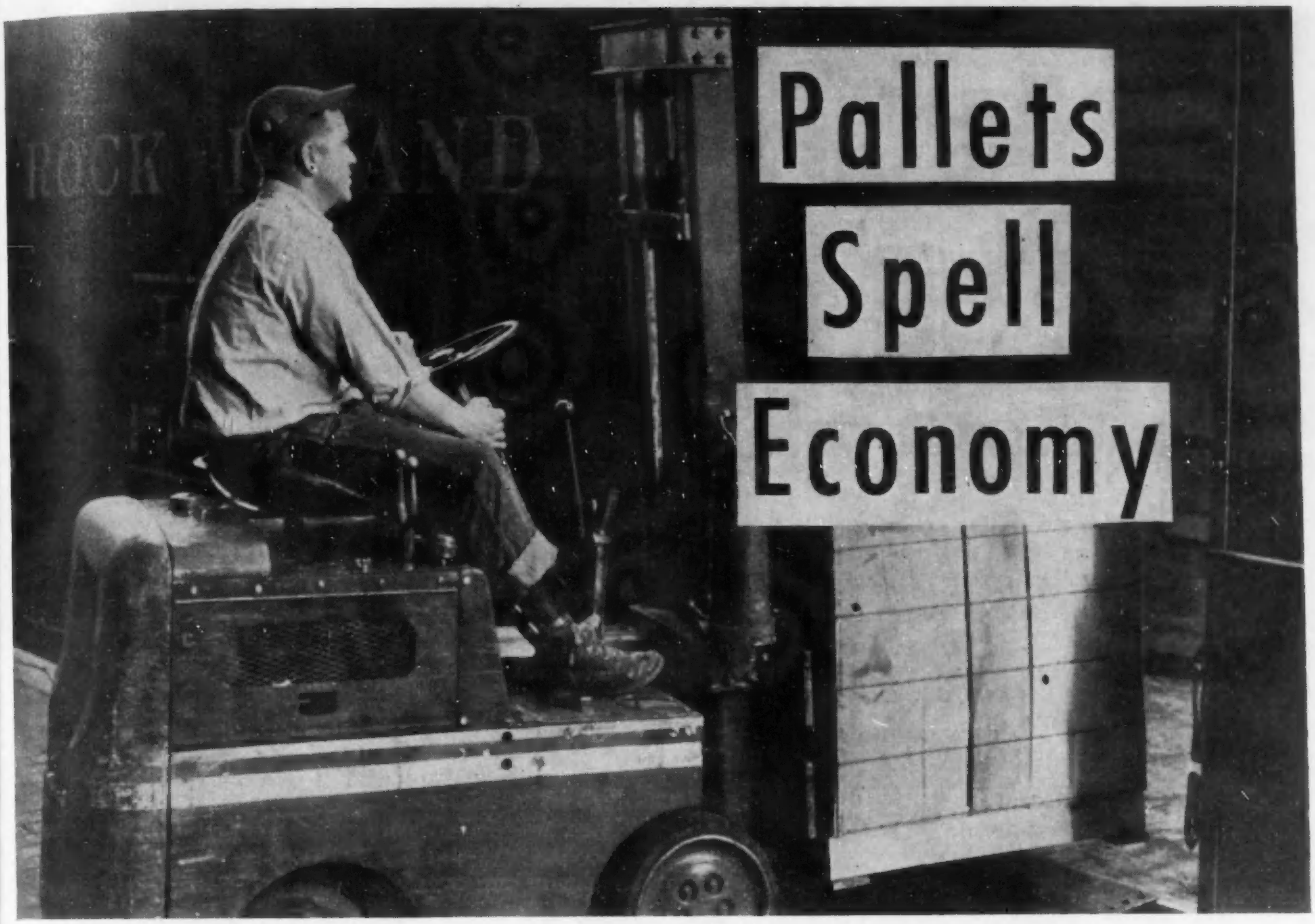
Stretches Mpg Too

These measures are more than justified if we keep in mind the fuel waste possible during certain periods of operation with high gasoline temperatures in the carburetor. Vapors vented from the float chamber represent a fuel waste. For example, during an idling period following full throttle operation 10 to 15% of the fuel may be lost by vapor venting.

Keeping down the entire fuel system's temperature gets more tank miles.

Since at this time motor vehicles will be replaced at a greater rate than ever before, there's no time like now to start to combat vapor lock in design of new equipment.

Pallets Spell Economy



BASED ON A PAPER* BY

W. L. Pearce and **C. L. Daly**

Assistant Manager, Parts Distribution, General Motors Parts Division

General Motors Parts Division

GENERAL MOTORS CORP.

RESEARCH, standardization, and redesign of equipment has achieved a revolution in materials handling which reduced loading and unloading time from one-half to one-third, cut damage to parts in handling and in shipment, and eliminated many bottlenecks in vehicle production and parts distribution.

In 1939, when production of vehicles was breaking records, the General Motors Parts Division launched a research program to smooth the flow of parts to assembly lines, to warehouses, and from major suppliers. It was soon found that millions of pounds of parts were being handled and rehandled by sheer manpower.

Six basic elements were developed to speed up materials handling and eliminate the bottlenecks. They were:

- Standardization on a single pallet size (48 x 36 in.); elimination of five other sizes. The loading fork works on either dimension. In some cases a 4 x 4 is used instead of a pallet. Sides can be installed for some types of parts.
- Working with fork lift truck builders to improve the design of equipment.
- Development of master shipping containers.
- Adopting improved storage techniques.
- Redesign of the picker's tag.
- Setting up loading procedures for factories, warehouses, railroad cars, and trailers to speed up handling time.

Although there was some resistance to changes at the factories, among principal suppliers, and shippers, a series of demonstrations of the effectiveness of the new program has resulted in wide cooperation.

More than 30,000 different parts and accessories are stocked for three GM automobile lines. These must be shipped to 45 warehouses in the United States in sufficient quantity to provide operating banks to supply dealers for given periods.

These shipments are made weekly, bi-weekly, or monthly depending on the rate of sale of parts, distance from source of supply, storage facilities, and other factors.

Zone warehouses carry accessories and all fast moving parts. Master warehouses stock both fast-moving parts for dealers and slow-moving parts in

*Paper "Pallet Loading and Shipping" was presented at SAE National Production Meeting and Clinic, Cleveland, Oct. 20, 1947.

Beautiful but costly parts stacking is individual handling of units. Stacked by hand for storage, each piece will later be handled individually to load on boxcars, and then will be handled again individually to unload, and again stacked at warehouse

Cylinder blocks (above, left) weighing 138 lb each piled individually on the floor. Adjacent to them are heads weighing 68 lb each. Lumber is used to properly segregate the parts for piling safely

Individually cartoned cylinder heads (above, right) make neat piles, but handling consumes a huge amount of time to pile, unstack, load on boxcars or trailers, unload at destination and stack

a number of zone warehouse shipping areas. Major Supply Depots maintain stocks of Chevrolet fast-moving parts for dealers and to replenish warehouse supplies in their areas, and fast-moving parts for Oldsmobiles and Pontiacs for dealers. Very slow-moving items are carried in the factory warehouses at Flint, Lansing, and Pontiac.

Major supply depots maintain inventory control records for the territories they serve. Replenishment of stocks of slow-moving Chevrolet parts are made from Flint, where the Chevrolet National Parts Control office is located. This office also issues orders to replenish parts to all warehouses for the other two car lines.

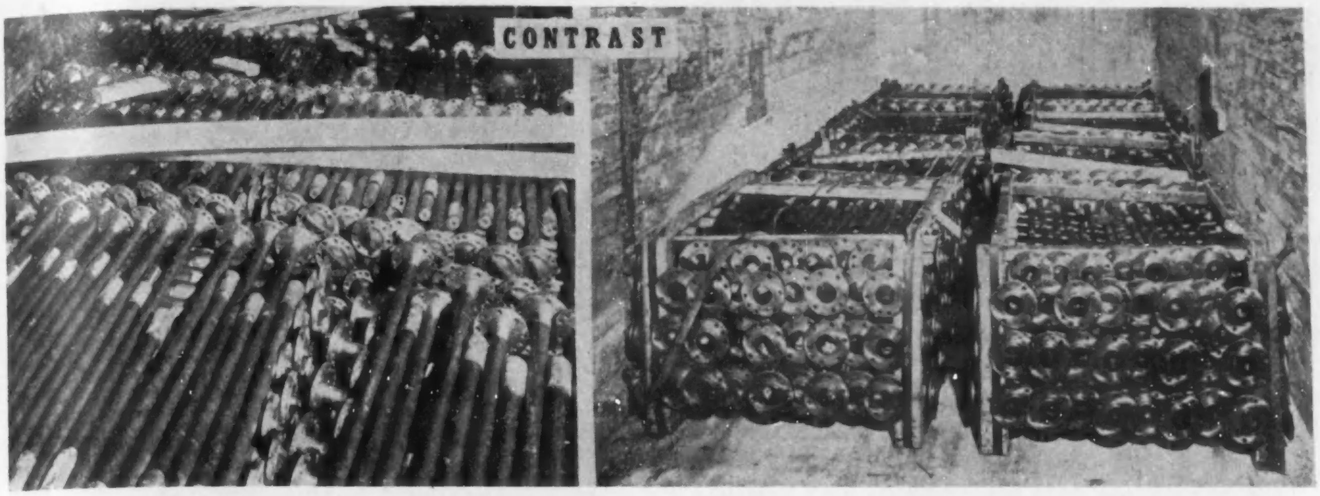
The major supply depot system was perfected in 1927. But the standard procedures then used created bottlenecks as production increased. Outgoing material was slowed, and storage and receiving functions were interfered with because too much space was required by material awaiting unpacking, repacking, and reshipment.

The platform skid generally used at that time with fork trucks was too large and too high off the ground for efficient handling. The present standard pallet has a base of two 2x4's on edge, with 1x4 or 1x6 cross pieces. Salvage material was found to be as good for this purpose as new lumber, opening the way for substantial savings. Wire mat sides

Palletized loads (below) of parts have saved untold manhours in handling more than 30,000 different parts and accessories to be shipped to 45 warehouses of General Motors Corp.

Loaded and anchored on pallets, these cartoned cylinder heads are arranged in a boxcar for shipment. The 28 heads on each of the three pallets weigh 1954 lb

Thirty-four crankshafts, each of which weighs 67 lb, are loaded on each of these pallets. Note steel strap used to anchor the cartons to the load and the pallet



Contrast the hand piled axle shafts and rear axle housings loaded in a boxcar (left) with the palleted axle shafts (right). Besides the difference in cost and time in handling these individually from the last machining operation to a truck, moved to the car, and then individually cross piled, damaged surface finishes are almost always inevitable. Pallets (right) are placed adjacent to the last machining operation, shafts are loaded and strapped, and moved by fork truck into the boxcar

are available when the load requires this protection.

Following successful experience at Flint, a major supplier was asked to load shipments to conform to Chevrolet's practice. A diagram showed proper placement of each pallet in a freight car for the fork truck operator. At first each pallet load was consecutively numbered to make proper loading as simple as possible.

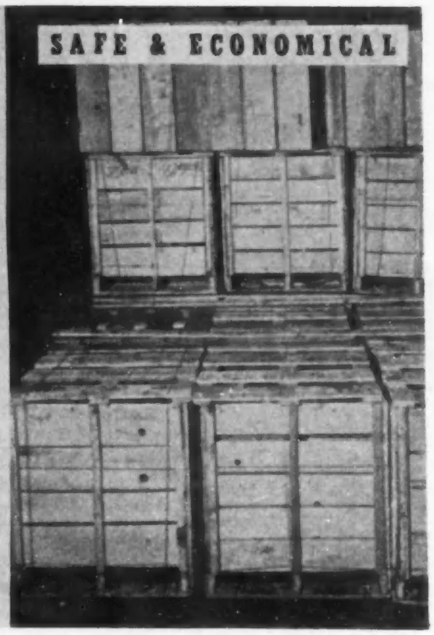
The initial 50,000 lb box car loading was accomplished in about half the usual time. The shipment arrived in excellent condition, and the unloading at Flint was completed in about one-third the normal time.

Following more successful experience with successively reduced number of pallet sizes and heavier total shipments, an 80,000-lb box car was scheduled and a demonstration of unloading was planned for the company's executives. Even the box car doorways were stacked solid, and the pallets were tiered in some parts of the car.

Despite the fact that the "Unload From This Side" tag had disappeared in transit, and the car had been spotted wrong side to and on a curve, the unloading crew cleared the doorway by muscle and the balance was unloaded with power equipment in about one-third the usual time. Management decided at once to adopt the program and the required equipment was obtained.

By this time a 3500-lb fork truck with a short steering radius had been developed with the aid of equipment manufacturers. Supplementary light

Below is a miscellaneous load from a supplier who individually stacked the load. The center picture represents a lot of damage to glass parts, which were cartoned but improperly palleted. Lower right is an in-process view of an 81,840-lb load, properly palleted and stacked with lighter material topside



Thirty containers, each holding six piston pins, are packed in a master container which holds 180 parts. Then 36 master containers are loaded and anchored onto pallets and loaded into boxcars or trailers. Pallet weight is 2111 lb

Telescopic fork trucks easily stack pallets and load others on mezzanine areas to achieve maximum use of cubic footage. Here a large pallet is being easily lifted and placed on the "upper deck" of a warehouse

fork powered lift dollies were designed to speed spot placement of loaded and empty pallets.

A galaxy of cartons, barrels, and boxes has now been replaced by a standard master shipping container. Quantities of each part per container have been established to avoid the constant unpacking and repacking that was previously required.

The dimensions of the container and the quantity-per-container information were supplied each supplier and the company warehouses.

Result of careful study and extensive research disclosed optimum stacking and tiering practices, depending on each class of material to be stored. Less total space is required by following the standard practices, and the amount of time in stacking and unstacking has been reduced greatly.

One of the bottlenecks in handling parts and accessories was found in the old picker's tag, an eighth carbon copy and often illegible.

A new tag was devised showing the unitizing code, telling the picker whether or not the material was to be unitized where the material was picked, the part number, its description, freight classification, quantity to be shipped, the order number, warehouse number, and the location in which the part was to be stored in the warehouse.

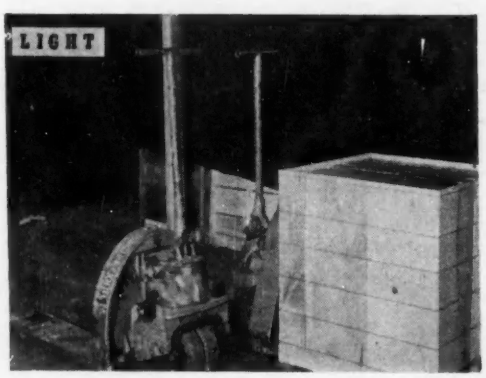
The tag is clearly legible, and contains the information needed to keep materials in smooth flow.

To help suppliers, common carriers, and shippers at Flint and the warehouses, optimum loading plans were established depending upon the materials to be handled.

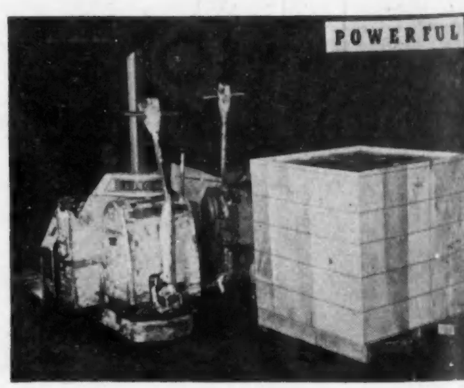
The pallets are loaded in pinwheel fashion, interlocked by reversal in alternate layers of parts or containers. A small open space is left in the center of the load, and the whole is anchored with steel wire or strap.

Besides the diagrams and instructions, scale models were furnished to show how the pallet and complete loads should look to assure safest transit and to decrease loading and unloading time.

Several of the U. S. Armed Services adopted details of the General Motors Parts Division plan of loading, unloading, and storage in the past war.



Hand pallet truck (left) for working in narrow aisles



Small electric-powered pallet truck (right) is efficient

Evaluate Light Plane Engine Oil In Flight-Simulated Lab Tests

BASED ON PAPER* BY
W. J. Backoff
N. D. Williams
K. Boldt
and J. G. Hall
THE PURE OIL CO.

AND DISCUSSION

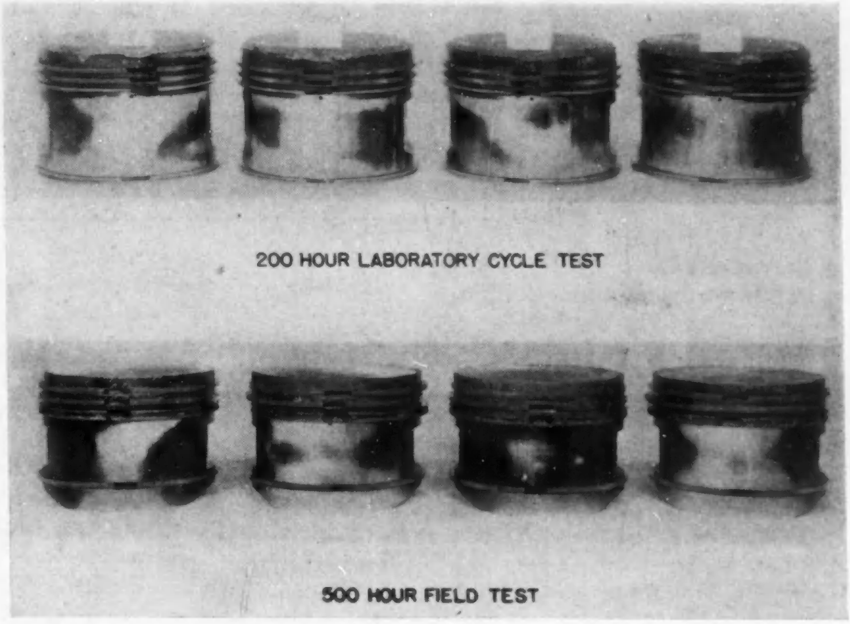


Fig. 1 – Correlation between accelerated laboratory tests for evaluating light aircraft engine oils and actual flight test results is shown here. The pistons above are subjected to a 200-hr laboratory cycle test which is about the equivalent of a 500-hr field – to which the pistons below were subjected

ONLY by developing light aircraft engine lubricants in terms of actual performance of these engines will a satisfactory oil emerge. Discussers agree with the authors that full-scale laboratory tests simulating service conditions are useful tools for this purpose.

Pure Oil prepared a laboratory test procedure, outlined in Table 1, based on actual flight tests which represent the extremes of small aircraft operation. The test is somewhat accelerated to minimize actual laboratory time. Recent flight tests with some lubricants showed that engine cleanliness ratings at 500 hr compare favorably with laboratory results obtained at 75 hr.

Discusser F. S. Wood, Standard Oil Co. (Ind.), concurs in the need for correlating laboratory tests with field data as a means of perfecting proper oils. His company developed a set of laboratory test conditions for a 4-cyl opposed 65-hp engine, given in Table 2. Fig. 1 compares the pistons after this 200-hr laboratory test with those taken from a 500-hr field test. Both engines ran with the same heavy-duty oil.

According to Wood, this laboratory test is extremely severe as to piston varnish, ring sticking,

concluded on page 84

Table 1 – Laboratory Dynamometer Test Procedure for Evaluation of Aircraft Lubricants

	Engine A		Engine B	
Part A – 50-Hr "Cold Sump" Test				
Hourly Cycle	RPM	BHP	RPM	BHP
5 min Take-off	2200	65	2600	75
50 min Cruise	1900	42	2350	55
5 min Idle	No Load		No Load	
Crankcase Temperature	120/150 F		120/150 F	
Part B – 25-Hr "Hot Sump" Test				
10 min Idle	No Load		No Load	
50 min Take-off	2200	65	2600	75
Crankcase Temperature	225 F Max		225 F Max	
Oil Drain Period – 25 hr				

Table 2 – 200-Hr Aircraft Engine Oil Stability Test

½ Hr Cycle	
3 Min Take-off Speed and Load	
22 min Cruise Speed and Load	
5 min Idle Speed and Load	
Spark-Plug Head Temperature	480-490 F
Oil Sump Temperature	160-170 F
Oil Drain Period	25 hr

*"Evaluation of Light Aircraft Engine Lubricants," was presented at SAE National Fuels & Lubricants Meeting, Tulsa, Nov. 7, 1947.

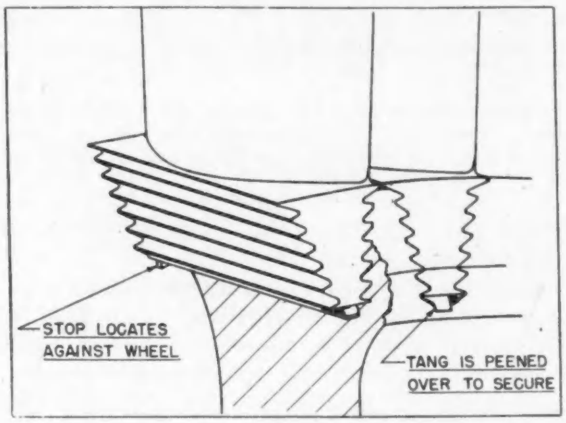
10 WAYS TO A

MANY different interpretations of how blades should be attached to wheels and casings of gas turbine powerplants have appeared. All of the designs aim at strength, low stress concentration, simplicity, ease of replacement, and strict economy of weight. Ten methods are described here.

1. Fir-Tree Attachment

Most satisfactory type of attachment for turbine buckets is the fir-tree type.

On this Rolls-Royce turbine bucket, tangs are machined at both ends of the root. One tang is



perpendicular to the face of the disc and forms a stop when the bucket is installed. After installation, the remaining tang is peened over to secure the bucket in place. The bucket is otherwise free in the groove, having about 0.050 in. of movement, as measured at the blade tip when the unit is cold.

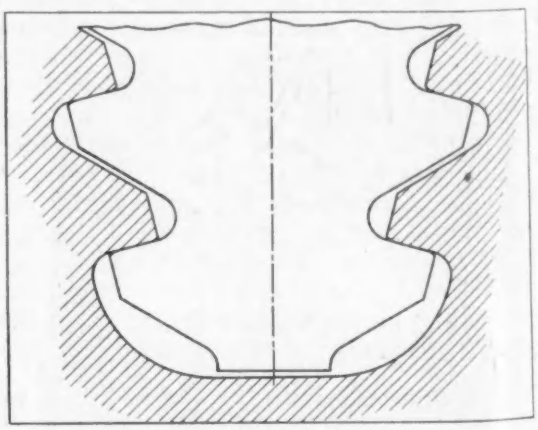
Radial looseness of the root in the disc compensates for differential expansion of materials and serves as a vibration damper. In operation, centrifugal force and expansion due to heat prevent movement, but the damping is still available. The British credit loose fit as one of the chief reasons for the relatively long life of their buckets.

DeHavilland and Bristol, as well as Rolls-Royce, use the fir-tree type of attachment. It has been used on the Westinghouse 19XB turbine and as an alternate attachment on the General Electric TG-180 turbine. The DeHavilland turbine differs from the usual design in that the root is fitted into the wheel with a slight tap fit.

Designers of fir-tree roots try to obtain uniform loading on the teeth and to reduce regions of stress concentration. Mating teeth nearest the center of the disc need slightly more clearance than outer teeth. Often the inner teeth carry too much of the load. This condition can be corrected by improving the fillet design.

Fir-tree roots are usually formed by broaching. Inaccuracies in broaching will throw the entire load on one or two teeth. Creep is one factor which tends to compensate for both poor design and poor broaching.

To prolong broach life, fir-tree branches on both root and disc are truncated.



* Paper "Turbine Engine Blading: Manufacturing Technique and Fastening Methods," was presented at SAE National Aeronautic Meeting, Los Angeles, Calif., Oct. 3, 1947.

ATTACH BLADES

BASED ON A PAPER* BY

A. T. COLWELL, And **R. E. CUMMINGS,**

Vice-President — Chief Engineer

THOMPSON PRODUCTS, INC.

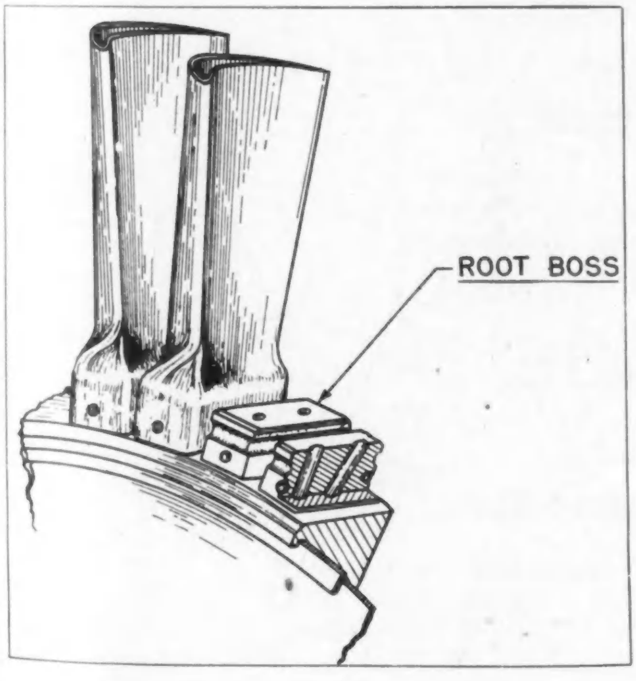
2. Soldered Attachment

On one design of the Junkers Jumo 004, the hollow, aircooled turbine buckets were fitted over machined bosses.

Cooling air for the bucket was forced through two radial holes drilled in the root boss.

The bucket was bonded to the boss by high-temperature silver-manganese solder. A groove machined around the boss held the solder wire.

Pins were inserted through the bucket and boss in the axial direction to hold the bucket in position.

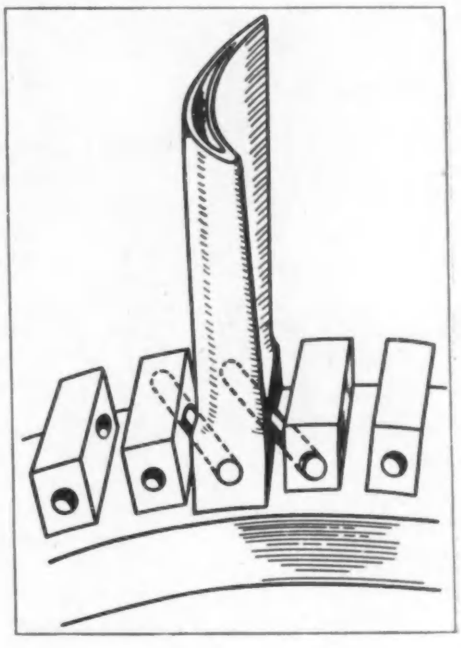


(This paper will appear in full in SAE Quarterly Transactions. The paper covers techniques of manufacturing turbine engine blading, as well as fastening methods.)

3. Diagonal-Pin Attachment

On another Junkers design for the Jumo 004 turbine, diagonal pins were used to secure the bucket in position on the periphery of the hub.

Here again, the hollow bucket was fitted over a boss machined on the turbine wheel hub. The diagonal pins held the bucket in position while it was being brazed onto the boss.

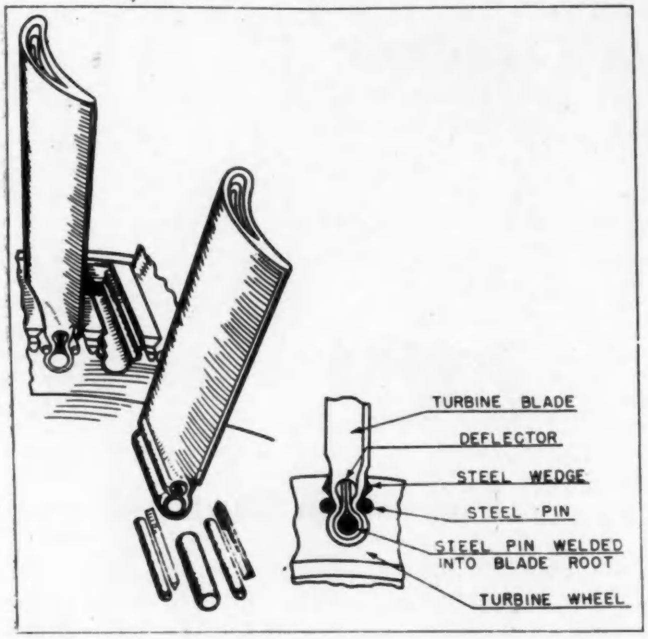


4. Wedge and Pin Attachment

The BMW 003 hollow turbine bucket was secured by three steel pins and two steel wedges. These were easily manufactured from rods of round and triangular cross-section.

One steel pin was welded into the blade root. The other pins and wedges fitted outside the root in grooves in the hub of the turbine wheel.

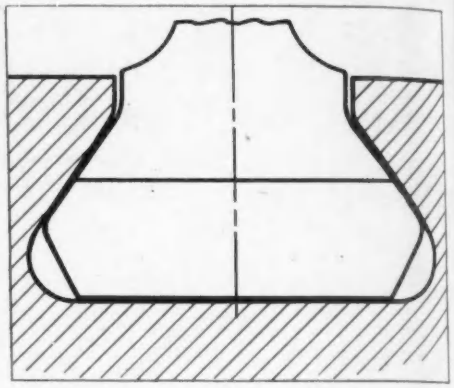
A deflector inside the root directed cooling air against the inner surfaces of the bucket.

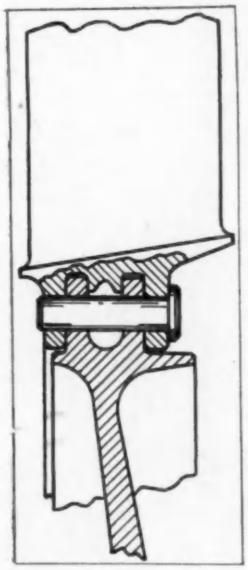


5. TG-180 Compressor Attachment

A root somewhat similar to a section of a fir-tree root is used with the rotating blades of the TG-180 compressor.

The blade is press-fitted into a broached slot. This design lends itself to gaging to provide uniformity in the fit. The press fit used is approximately 0.0015 in.



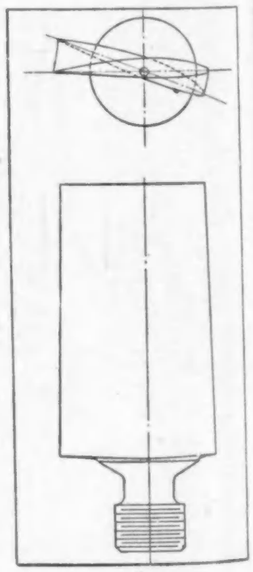


6. Hinge Attachment

The hinge-type (or pin-type) attachment is favored because of the extreme ease with which blades can be replaced in the event of damage.

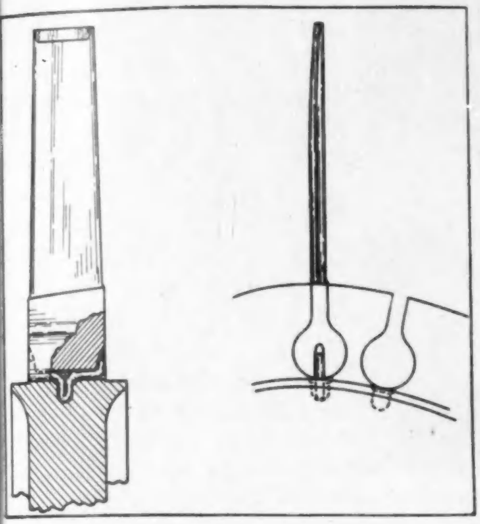
7. Threaded Roots

Many experimental compressors are built with screw-type roots on the rotating blades. The threaded shank provides a means of adjusting the blade angle.



8. Ball-Root Attachment

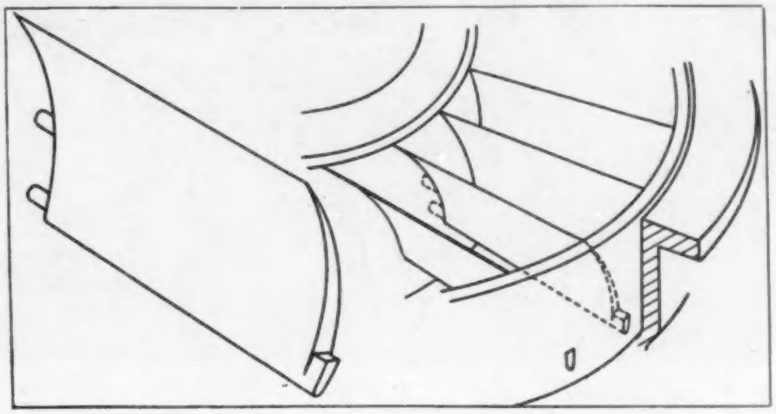
A ball-root design is used for the 19XB compressor blade attachment. The blade fits tightly in the slot. Fore-and-aft movement is restrained by a locking wire engaging both disc and blade.



9. Riveted Vane Attachment

In the DeHavilland Ghost powerplant, turbine vanes are riveted into place. A single peg at the outer diameter is inserted into a hole punched in the outer shroud. Two pegs at the inner end of the blade are riveted after installation.

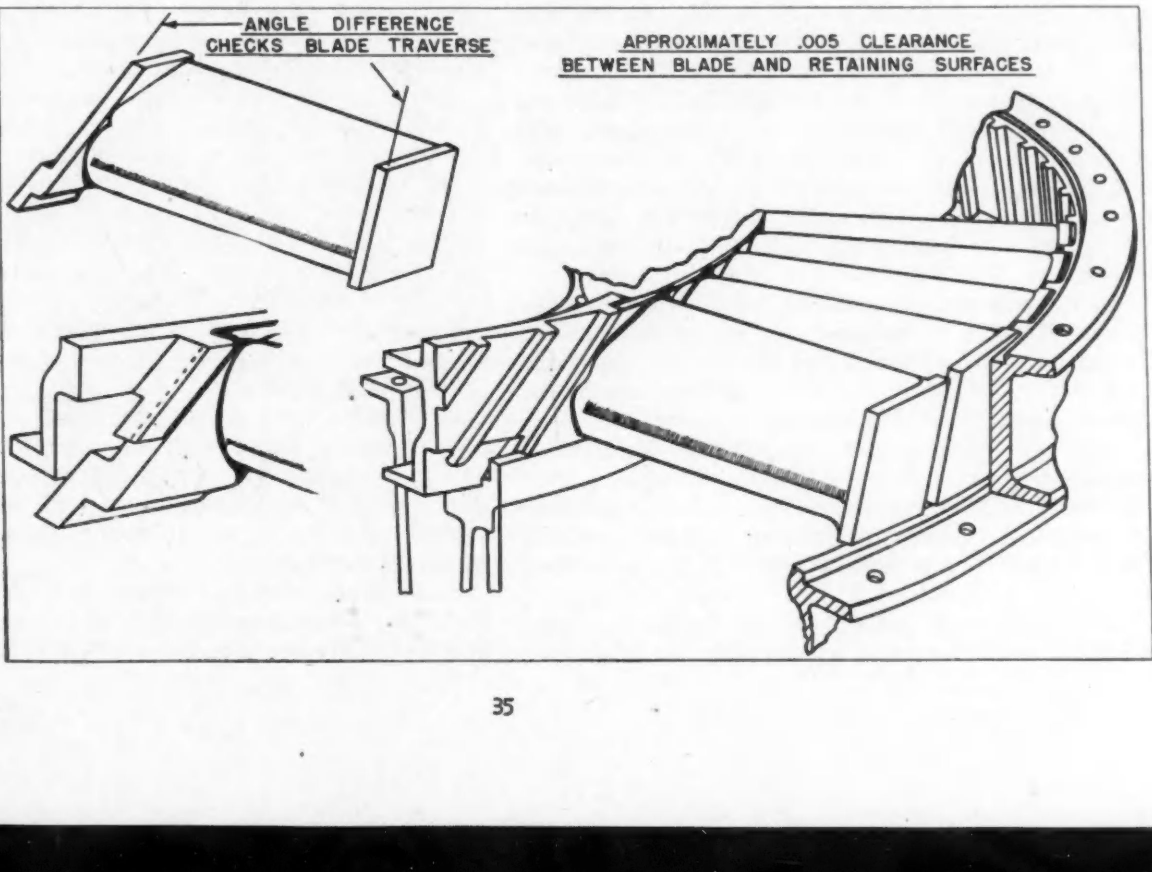
The outer shroud is slotted to provide freedom for expansion.



10. Floating Vane Attachment

Rolls-Royce leaves the turbine vane free to float between its retaining surfaces. The clearance is approximately 0.005 in. Its purpose is to prevent buckling of the vane due to thermal stress.

The sides of the blade root and cover are not parallel to the axial direction, nor to each other. The angle between them checks blade movement in the axial direction.



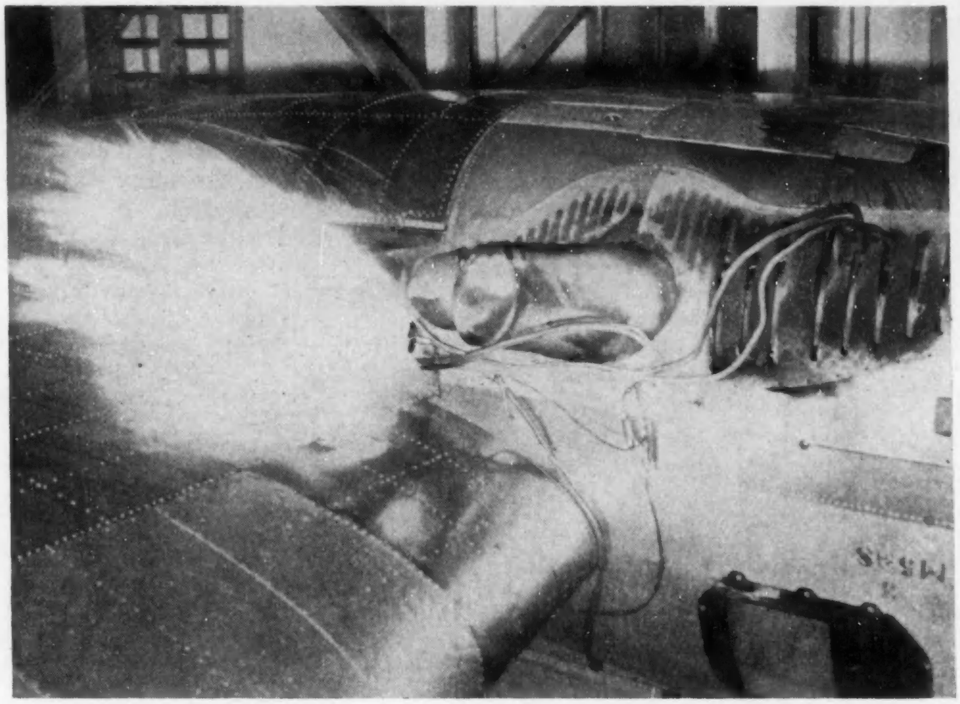


Fig. 1 – Fire following spark ignition of standard hydraulic fluid

CAA

BASED ON A PAPER* BY

Harvey L. Hansberry

Chief, Powerplant Section
Technical Development Service, CAA

AN extensive aircraft fire prevention program is being conducted at the CAA Experimental Station in Indianapolis.

Although many of the necessary tests have not yet been completed, some tentative conclusions have been developed, based on data gathered to date:

1. Fire-retardant coatings for doped-fabric aircraft surfaces: Fabric treated with cellulose acetate-butyrate (C.A.B.) dope appears to be less hazardous than that treated with cellulose nitrate dope. In tests on a Waco YkS37, the C.A.B. doped fabric withstood the flame for about 6 sec and burned only in the areas exposed to the flame. When fabric was covered with cellulose nitrate dope, however, it withstood the flame for only 3 sec, and the fire spread rapidly from the point of ignition.

Six seconds was considered insufficient time for extinguishing a powerplant fire, and it appeared that the tautening ability of the C.A.B. dope was incompatible with the fire-retardant characteristics required, so it was decided to concentrate on developing fire-retardant coatings to be applied over the doped fabric.

A study of 560 possible coatings indicated that several of them may provide definitely improved fire retardation. It also appears that more than four coats of these materials give additional fire protection over a lesser number of coatings.

Weathering tests are now being conducted with the coatings having the best possibilities.

2. Hydraulic fluids: Tests of several new fluids in a B-29 installation under simulated flight conditions and in a bench test under simulated crash conditions indicated that, with one exception, they are less easily ignited than the standard hydraulic fluid. (See Fig. 1.) Hydrolube proved to be the best fluid of all, since, for all practical purposes, it was not ignitible. Type A fluid of the California Research Corp. is not ignitible under almost all conditions and would be nearly as safe in aircraft as the Hydrolube.

A practical and standardized testing procedure, not requiring the use of an aircraft engine, by which any laboratory could determine the relative ignitibility of hydraulic fluids, and possibly other aircraft fluids, is apparently a possibility and would be desirable.

3. Aircraft vacuum system: Partial or complete blockage of the pressure side of the system causes pressures above 100 psi and air temperatures

* "CAA Aircraft Fire Prevention Developments" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1947.

REPORTS PROGRESS in Fire Prevention Work

above 850F, which can readily give rise to internal fires. Damage due to fires can be reduced, the tests showed, by using lines and fittings made of highly fire-resistant materials, thereby confining the fire until the pump fails. It was also discovered that a fusible plug will relieve the pressure if extremely high temperatures are attained, thereby lowering the temperature without rendering the vacuum system completely useless.

It is recommended that fire-resistant plumbing development be continued, with consideration being given to internal as well as external fire resistance.

4. Effect of powerplant fire on integral wing tanks: Although a good many tests still need to be run, those conducted so far indicate that an engine fire large enough to reach back at least half way across the wing is likely to burn through the top skin of an integral tank located in the path of the flame, if the fire lasts at least 30 sec. An explosion is not likely to occur and the bottom skin of the fuel tank will not burn through as long as there is liquid in the tank, but there will be a localized fire near the burned hole, which probably cannot be blown out unless the hole in the skin is less than 10 in. in diameter. Although a fire within an integral wing tank is not violent, it is generally persistent, so that it will continue to burn even after the original powerplant fire is extinguished.

5. Powerplant fire ignition sources: The exhaust system appears to be the most serious cause of fire – at least on the B-29. The exhaust not only ignites any fluid that has been exposed to it, due to an independent failure of the fuel or oil systems, but in itself frequently causes the fuel system to fail and then provides the ignition.

Present efforts are being concentrated on the exhaust stack well. Tests are being conducted on the B-29 and in a related bench test program to determine whether a condition can be produced within the exhaust stack well that will prevent ignition of any fluid, in any quantity, discharged into it. Although the basic work is being done on the B-29, the purpose of the supplementary bench test is to expand the results to obtain general design criteria.

The first supplementary bench test arrangement has been completed. It comprises an air duct through which various rates of airflow are forced by a small blower. A smaller tube, heated by an internal flame, passes through the duct at right angles to the duct centerline. The variables to be controlled include: the airflow through the duct, the temperature of the heated tube, the tube material, the size relationship between the heated tube and the air duct, the fluids to be discharged upon the heated tube, and the means for discharging the fluids.

6. Safety fuel versus regular gasoline: Tests with hot surfaces indicate that there is no added safety to be gained by the use of so-called "safety fuel," as compared with regular gasoline. Work is still continuing on this matter.

7. Additional programs in progress or planned:

a. Development of a standard fire detector test burner – 90% complete.

b. Development of a standard detector test bench – 95% complete.

c. Development of a standard test bench for evaluating efficiencies of extinguishing agents in radial engine power sections – being initiated.

d. Development of a standard test bench for evaluating efficiencies of extinguishing agents in radial engine accessory sections – to be initiated.

e. Tests on a P & W R-4360 engine installation in a Navy XR60-1 airplane, including: fire detecting system developments; fire extinguishing system developments; fire extinguishing agent studies; development of improved design criteria to eliminate fire hazards; development of improved compartmentation, and determination of proper uses of fire-resistant materials; clarification of correct crew procedure in event of a fire in flight.

Facts, Physical and Chemical, About Propane and Butane

Propane, butane, and mixtures of them are the principal liquefied petroleum gases currently marketed. They are obtained from three principal sources: (1) natural gasoline plants where they are recovered from the dry gas and gasoline removed from crude oil; (2) recycling plants from the wet gas drawn from natural gas wells; and (3) oil refineries where the crude oil is processed into commercial gasoline, fuel oils, and distillates.

Chemically propane and butane are members of the paraffinic hydrocarbon group having the basic formula C_nH_{2n+2}. Formula for propane is C_3H_8 and that for butane is C_4H_{10}. Thus propane and butane fall into the same general classification with methane on the one hand and octane on the other. However, liquefied petroleum gases have physical properties compromising these latter two hydrocarbons in that they can be liquefied under moderate pressure.

They were named "liquefied petroleum gases" because they exist only in the gaseous state when allowed to expand at room temperature.

HOW to A

BASED ON A PAPER* BY

E. A. Jamison

Manager, Industrial and Utility Section

and J. R. Strother

Sales Engineer, Philgas Division, Phillips Petroleum Co

CONVENTIONAL vehicle engines can be modified to take advantage of propane and butane fuels' high antiknock qualities. Other properties of these liquefied petroleum gases also make them useful in farm equipment. In the light of increasing availability and attractive price of such fuels, these two factors offer inviting possibilities to both the motor vehicle and tractor industries.

High antiknock qualities of these liquefied petroleum gases (LP-Gas) permit high engine compression ratios. This increases power and lowers specific fuel consumption. Also associated with dry gas fuel are the absence of crankcase dilution and substantial reduction of carbon formation within the power section.

Laboratory antiknock test data are not all consistent. Table 1 indicates propane and butane antiknock ratings by various test methods.

Substantial increase in compression ratio can be made provided the engine can withstand the increased cylinder pressures and bearing loads safely. But neither the gain in engine power nor reduced fuel consumption varies as a straight line function with increase in compression ratio. Although power increases and fuel economy improves in the order of 2 to 3% for each ratio increase at 6.0 to 8.0:1, the gain at 12.0:1 is reduced to less than ½%. Increasing compression ratios beyond 15.0:1 yields virtually no advantage.

Adapting Engine to Fuel

Most design changes incorporated in conventional engines powered by LP-Gas take on the following basic features:

1. Compression ratio of 7.0 to 9.0:1;
2. Cold intake manifolds;
3. Optimum spark timing;
4. Cold spark plugs;
5. LP-Gas carburetion equipment.

A 7.0:1 compression ratio is somewhat conservative even for straight butane, which has a lower antiknock rating than propane. But this is a good starting point for development testing. Compression ratios from 8.0:1 to 8.5:1 appear to be the practical limit for butane. Increases beyond this point require propane mixtures to raise the antiknock rating further.

Actual compression ratio limit depends on both engine design and means by which ratio is increased. For example, small high-speed engines get by with higher ratios than larger ones. L-head engines seem to be less sensitive to variations in knock qualities; but they don't react as favorably as valve-in-head engines from power and fuel economy standpoints.

While 9.0:1 compression ratio is by no means a ceiling for propane for knock, it is the practical limit as regards engine life and fuel cost. The cost

Table 1 – Knock Ratings of Propane and Butane by Various Methods *

Method**	Knock Rating of Propane M1 TEL in Iso-octane	Equivalent Octane Number
Research (F-1)	1.90	111.8
ASTM (Motor)	....	97.1
F-3 (1-C)	0.08	101.7

Knock Ratings of Propane and Butane by Simulated Research (F-1) Test Method

Fuel	Critical Compression Ratio	Equivalent Octane Number
Propane	12.0:1	Iso-octane + 4.7 cc
Butane	8.0:1	Iso-octane + 0.2 cc

* Data obtained in 1946.
** Reported by National Bureau of Standards.

* Paper "Butane and Propane as Tractor Fuels," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 17, 1947.

ADAPT MOTOR VEHICLES to PROPANE and BUTANE FUELS

consideration stems from the desirability of maintaining an LP-Gas blend as high in butane content as possible since butane has roughly a 10% greater heating value. This saves about 10% in fuel cost where butane and propane are sold at the same price per gallon.

Cold intake manifolds, though not absolutely necessary, are recommended to offset partially the loss in volumetric efficiency with LP-Gas. The conventional carburetor atomizes the gasoline in the air stream where the charge-mixture temperature drops as much as 40 to 50 F. Using butane or propane in the dry gas state precludes taking advantage of this feature so that the engine suffers as much as a 5% drop in volumetric efficiency.

To counteract partially the effect of using a gaseous fuel, cold intake manifolding is used wherever possible. This is done by removing the heat box from the manifold and by attaching suitable shields to retard the radiation of heat from nearby exhaust piping. Rigging the carburetor air intake to draw cold air further improves engine performance.

Pressure Injection Prospects

While on the subject of introducing fuel in the dry gas state, use of LP-Gas by pressure injection of liquid fuel is worthy of mention. Because propane and butane vaporize so readily, their use would make fuel nozzle design far less critical. Nozzles would be much less inclined to clog because these fuels deposit surprisingly little carbon. These views are mere hypotheses since they have not been put to test. But they are served up as food for thought.

Need for optimum spark timing in engines adapted to LP-Gas is obvious. Because these fuels have high antiknock ratings, advantage should be taken of the power increase and fuel economy improvement available when advancing to optimum timing.

The spark curve does not follow that for gasoline. Rate of flame propagation for LP-Gas is somewhat slower than for gasoline. Experience has shown optimum timing may be up to 5 to 10 deg earlier than the optimum for gasoline.

Cold spark plugs are recommended with LP-Gas to reduce the likelihood of spark-induced preignition within the combustion chamber. Higher cylinder temperatures accompanying an increase in compression ratio heat the spark plug and exhaust valve more than at conventional ratios. Installing the coldest plug available will help avoid hot spots. And there is no need for hot plugs since lead accumulation and carbon formation are not problems.

Most consideration in modifying vehicles for LP-Gas should be given the carburetor. All recognized LP-Gas carburetion systems consist of two or more units. Fuel leaves the high pressure container under its own vapor pressure and is piped through heavy wall tubing to a heat exchanger unit. Here heat is absorbed from the engine cooling water and liquid pressure reduced to some intermediate value by a diaphragm-actuated pressure regulator.

The vapor absorbs more heat and a second pressure-reduction stage takes place. By now the fuel is a dry gas and its pressure is slightly less than atmospheric; venturi suction is required to introduce it into the engine.

The carburetor itself is a simple mixer consisting of a metering device – such as a venturi – to proportion air and fuel. The fuel enters the air stream through a fuel tube or through ports in the venturi.

There are many variations and refinements of this equipment. Some reduce to final pressure in but one stage, others in three stages of pressure regulation. Several manufacturers provide a positive lock-off device to eliminate gas leakage when the engine is not running; starting can be accomplished only by mechanically opening the lock-off. Others depend on the seating of the final-stage gas regulator for fuel shut-off.

Carburetion equipment has been refined to the point where it may now be said, with reasonable safety, that little is to be gained from further refinements. Goals now aimed for by carburetion equipment manufacturers are greater standardization and interchangeability of parts and lower costs.

Need for special top cylinder lubrication depends entirely on the type of service to which the engine

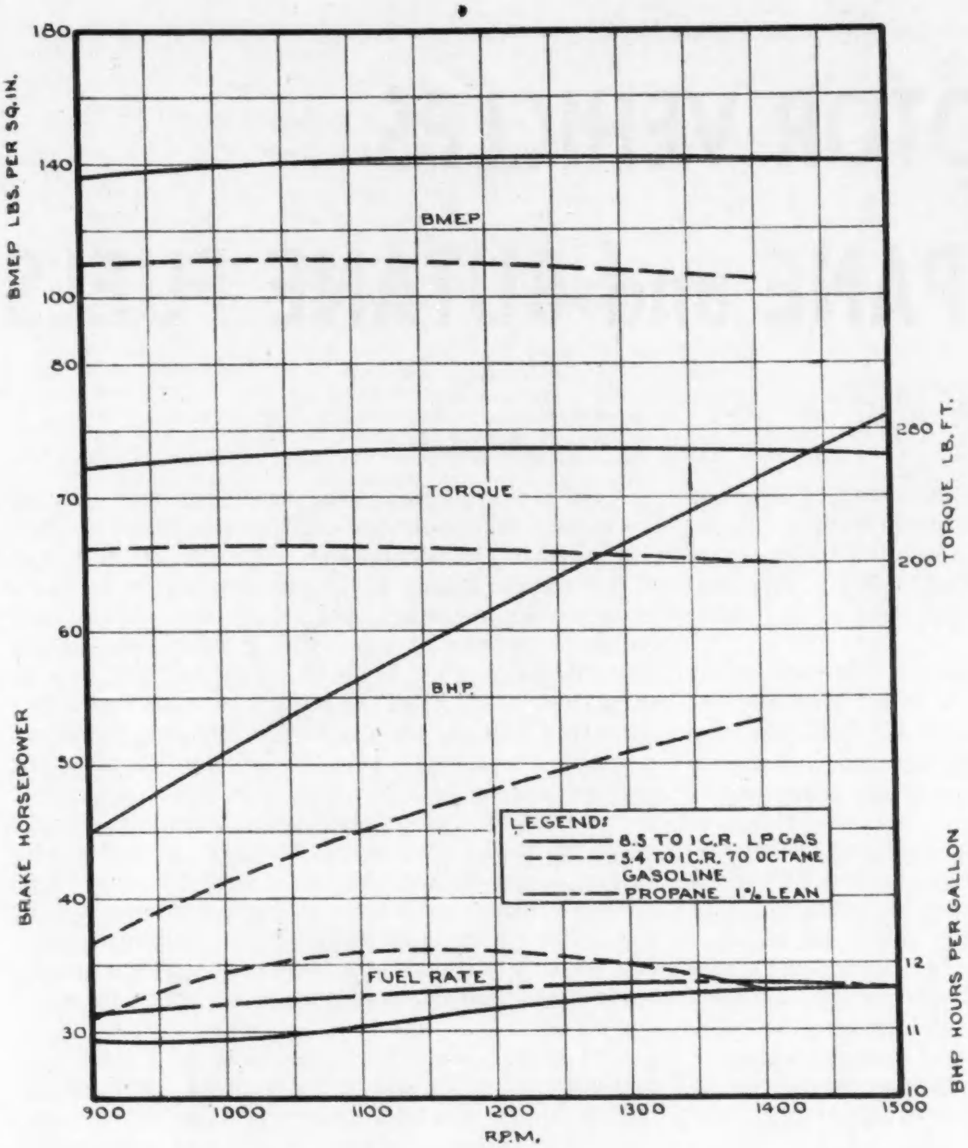


Fig. 1 – Performance curves comparing gasoline versus LP-Gas in a Minneapolis-Moline KEF engine of 283.7 cu in. displacement with 4¼-in. x 3-in. bore and stroke

is subjected. For most automotive applications where the engine operates at reasonably high engine speeds, such as trucks and tractors, the piston rings maintain oil control. The designer can change the power section at high discretion through a wide range of dryness or oiliness. These circumstances obviate the need for a top oiler.

On the other hand many applications such as stationary units involve long idling periods. With LP-Gas this produces a severe drying effect which may be overcome with a top cylinder lubricator.

Performance curves in Figs. 1 and 2 for representative engines show what can be expected by making these design changes.

While LP-Gas is important to the farmer as motor fuel, it also helps him in many other jobs around the farm. Besides its numerous domestic uses, LP-Gas has achieved notable success in farmland cultivation in weed burning and as a fuel for grain and alfalfa-drying operations.

LP-Gas has been found an ideal fuel for burners used to check weed growth in certain types of crops. Theory has it that when some hardy crops reach a certain size, they withstand flames sufficiently deadly to destroy nearby weeds. Butane and propane lend themselves to this use since they vaporize very readily, burn cleanly, and the flame is kept easily under control.

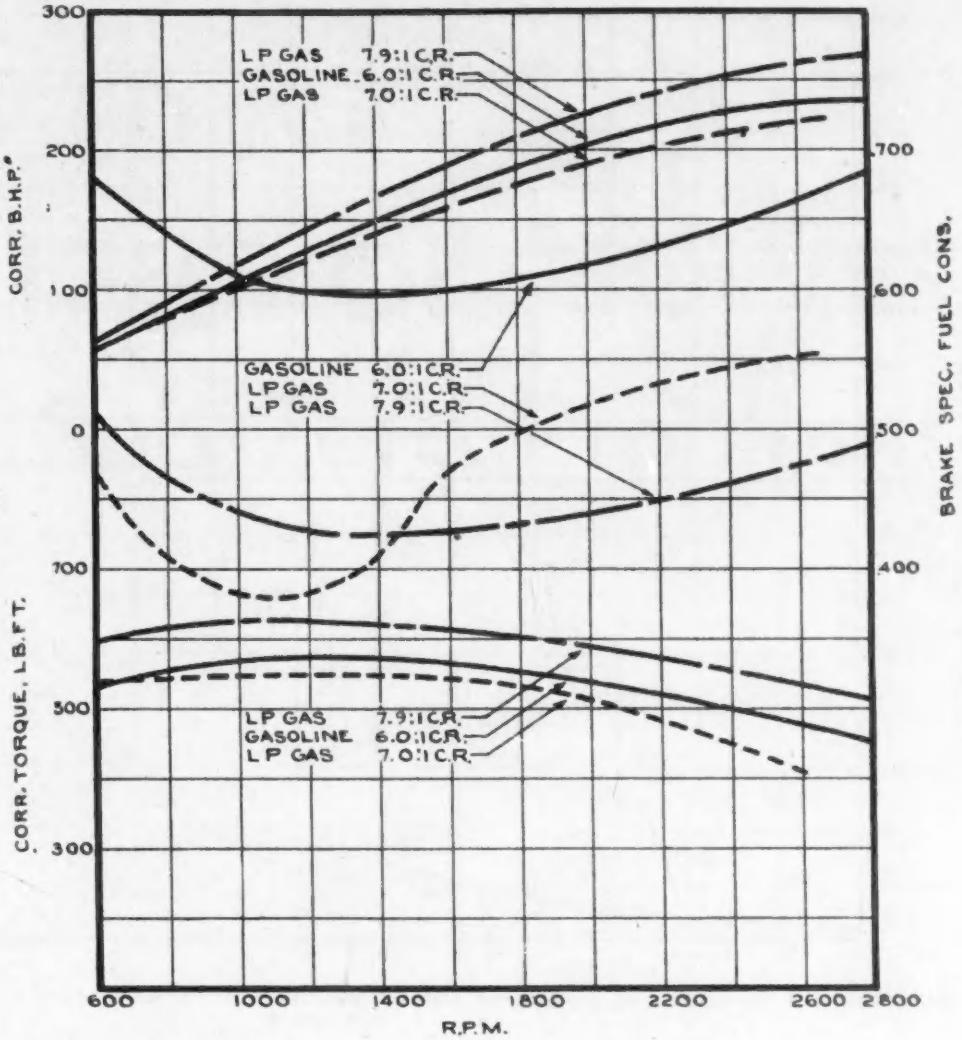
And because of its clean-burning characteristics, LP-Gas has proved itself an excellent fuel in drying, dehydrating, heating stock watering tanks, for incubators and brooders, for pasteurization of milk, and for sterilizing instruments and utensils.

Other Favorable Factors

The price trends, future availability of fuel, and distribution practices in the LP-Gas industry are factors which should help promote wider use of these fuels.

The price of LP-Gas dropped from 11¢ per gal in 1926 to 2.5 to 3¢ per gal in 1941 (f.o.b. Group III Oklahoma shipping points). Inflationary tendencies since the war have boosted the price of butane

Fig. 2 – These curves compare performance of a heavy-duty engine running on 80 octane gasoline and on an 80-20 mixture of propane-butane. The tests were run on maximum power mixture and optimum spark, except as limited by detonation on gasoline



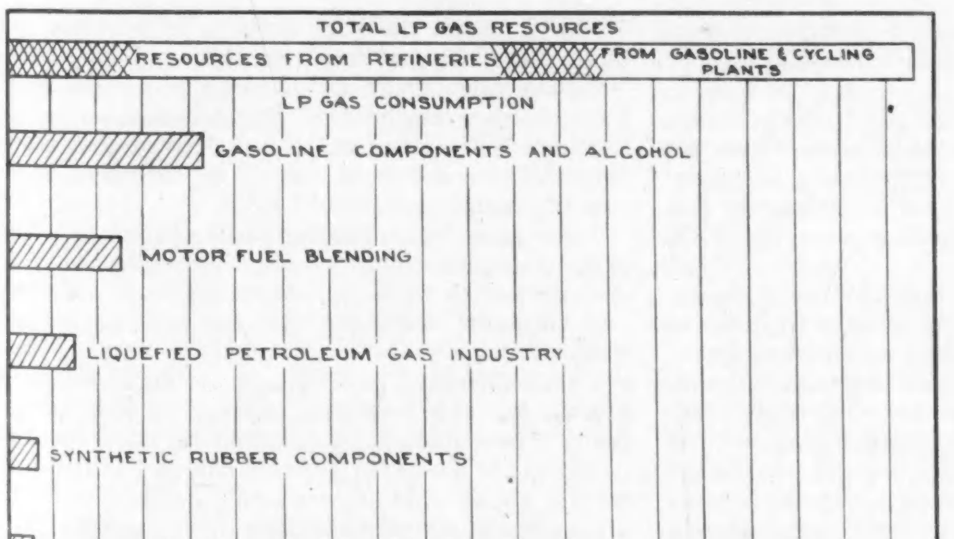


Fig. 3 – Estimated average daily resources and consumption of liquefied petroleum gas during the first six months of 1946

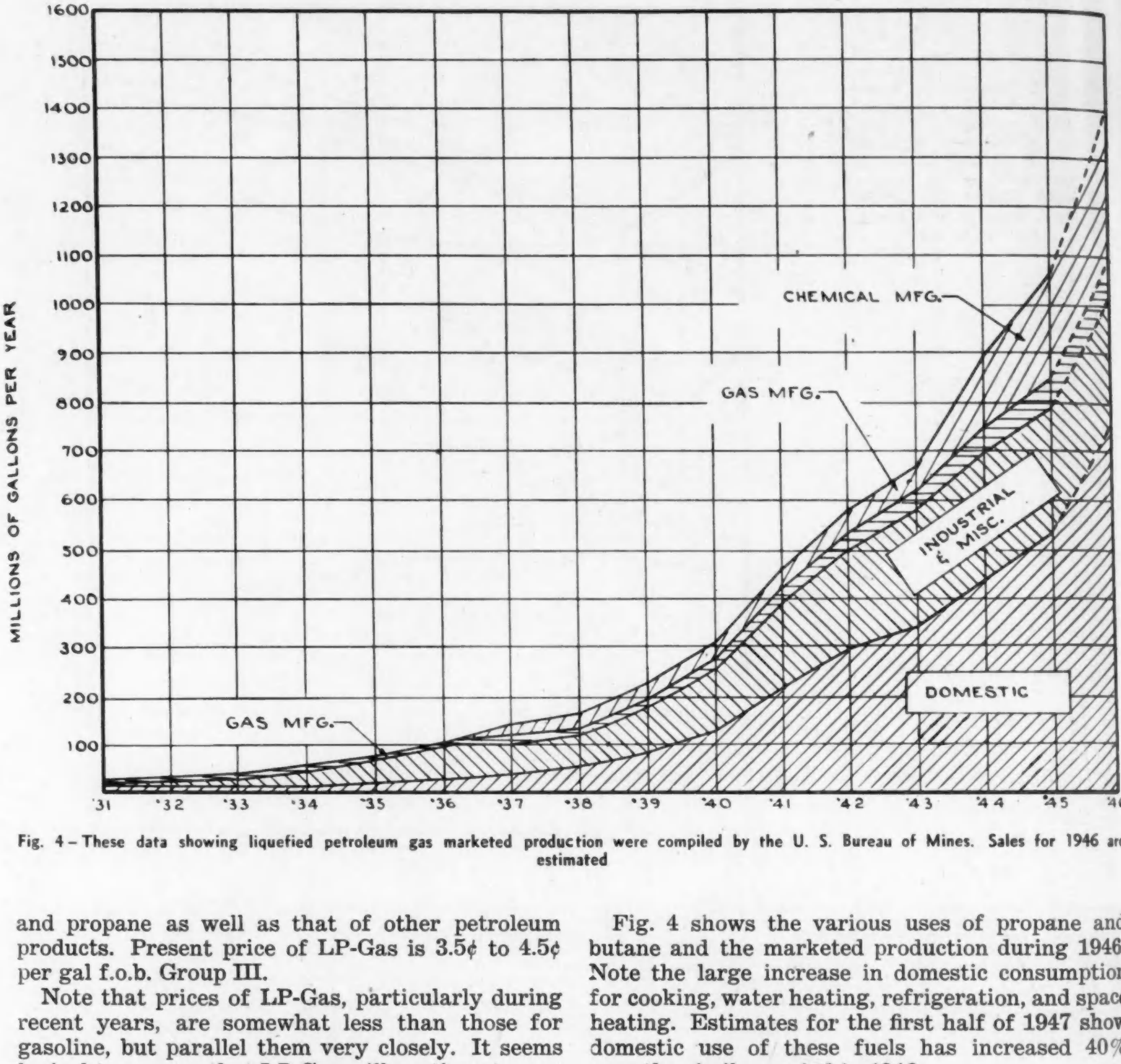


Fig. 4 – These data showing liquefied petroleum gas marketed production were compiled by the U. S. Bureau of Mines. Sales for 1946 are estimated

and propane as well as that of other petroleum products. Present price of LP-Gas is 3.5¢ to 4.5¢ per gal f.o.b. Group III.

Note that prices of LP-Gas, particularly during recent years, are somewhat less than those for gasoline, but parallel them very closely. It seems logical to assume that LP-Gas will continue to cost 3¢ to 4¢ per gal less than gasoline, on a Group III basis.

Because postwar demand for LP-Gas temporarily has exceeded ability of producers to increase production facilities, there is an erroneous impression that a propane and butane shortage will continue. Fig. 3 shows that there are potentially available about 14.5 billion gal per year of propane and butane. The chart shows only a small percentage of this volume currently goes into normal LP-Gas marketing channels. Thus it seems reasonable to believe that: (1) LP-Gas Production will keep pace, for a number of years, with demands for the products and, (2) the fuel required by the oil industry itself will be taken from the quantity normally allotted to lower price fields from lower price uses such as carbon black manufacture and refinery fuel.

Fig. 4 shows the various uses of propane and butane and the marketed production during 1946. Note the large increase in domestic consumption for cooking, water heating, refrigeration, and space heating. Estimates for the first half of 1947 show domestic use of these fuels has increased 40% over the similar period in 1946.

These figures should interest the tractor industry particularly since they show an increasing number of farm homes have LP-Gas. Many have 350, 500, and 1000-gal tanks and use the fuel for winter heating.

Trend is toward greater summer fuel uses such as weed burning, irrigation engine fuel, and tractor fuel. This condition is particularly prevalent in California and certain Texas areas and will spread rapidly to all middle western, southeastern, and southwestern states. Especially during the past two years tank truck distribution of propane and butane has become commonplace. Few communities in these areas have no LP-Gas tank truck service available to them.

Excellence of propane and butane as motor fuels together with their other advantages will increase greatly the demand for LP-Gas fueled tractors.

PROPOSED LIGHT OIL SOLVES Sub-Zero Problems

BASED ON A PAPER* BY **E. W. UPHAM**

Chief Metallurgist, Chrysler Corp.

and H. C. MOUGEY

Technical Director, Research Laboratories Division, GMC

(This paper will be published in full in SAE Quarterly Transactions)

WINTER tests in northern United States and Canada reveal that automobile instruction book recommendations for the lubricant to be used for temperatures below —10F are unsatisfactory. The lubricant recommended for these temperatures is 10W diluted with 10% of kerosene. Tests show that under present day driving conditions, this is an unstable lubricant, since the kerosene is lost by evaporation. SAE 5 or 5W sub-zero oil, now being considered for adoption by the SAE Fuels & Lubricants Technical Committee, corrects this difficulty. Although test data show that it is a satisfactory lubricant as regards engine wear, the proposed light-grade oil is consumed at higher-than-normal rates.

Cold-Starting Tests

Cold-starting tests conducted at —10F by General Motors Corp. on 28 representative American passenger cars show car instruction book recommendations for 10W down to —10F to be optimistic. Even with fresh 10W, an expert driver might find difficulty in starting a car at —10F.

Table 1 charts the test data on these 28 cars. All were in good mechanical condition and serviced with "Regular Type" 10W engine oil. The viscosities vary because some cars were approaching their 3000-mile drain period, others had been recently drained. Thus this Regular Type oil had more time to oxidize and increase in viscosity in some cars than in others.

Analysis of the cars in three groups show the following:

- Group 1 – The seven cars with crankcase oil viscosity not over 9000 SUS at —10F started in less than ½ sec.
- Group 2 – Of the nine cars with crankcase oil viscosity between 10,000 and 25,000 SUS at —10F, only five started. Time-to-start varied from 42 sec to 3 min 6 sec. From the driver's standpoint, all of these starts took too long.
- Group 3 – Only one of the 11 cars with oil viscosity between 30,000 and 47,000 SUS started at all. And this car took 37 sec for the first explosion and 50 sec to start. In the last two cars in this group with the highest viscosity oils – 45,000 and 47,000 SUS – the battery voltage was lowered to

*Paper "Sub-Zero Automotive Crankcase Oils," was presented at SAE National Fuels & Lubricants Meeting, Tulsa, Nov. 7, 1947.

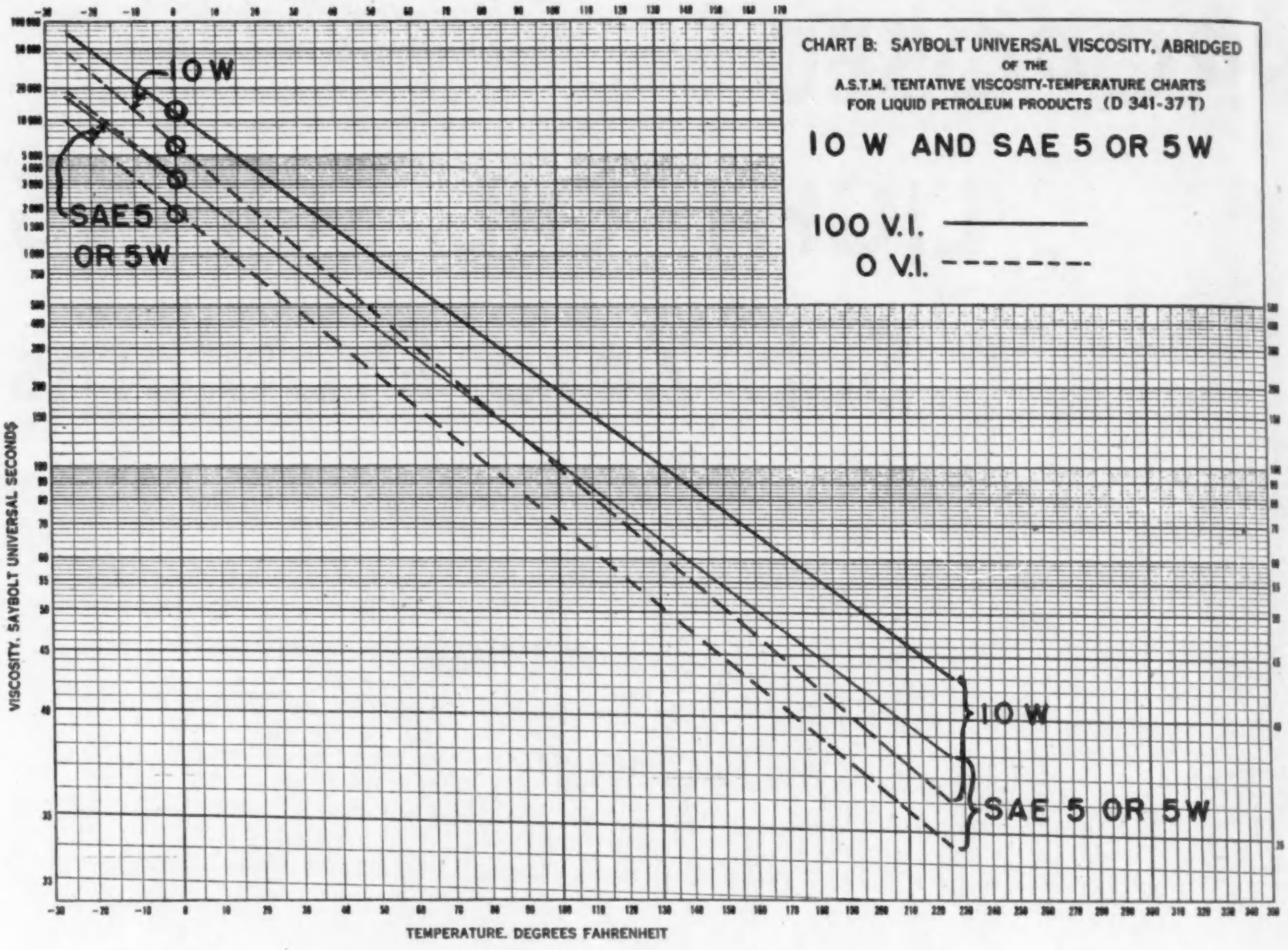


Fig. 1 – Viscosities of SAE 10W and SAE 5 or 5W oils compared

Table 1 – Outdoor Starting Test* Results with SAE 10W Oil

Car No.	Crankcase Oil Viscosity at −10 F	Time in Min and Sec to First Explosion	Time in Min and Sec to Start	Rpm Cranking Speed at 4 Sec	Time in Min and Sec Tried No Start	Volts at Battery Before Cranking	Volts at Battery While Cranking (at 5 sec)	Amperes While Cranking (at 5 sec)
31	5800	0:05	0:09	No record		6.4	4.4	360
32	6000	0:05	0:12	50		6.6	4.5	330
33	8000	0:13	0:17	No record		6.3	3.0	325
34	8000	0:05	0:21	35		6.2	3.4	300
35	8000	0:11	0:17	30		6.4	4.0	340
36	8000	0:11	0:26	40		6.3	3.6	325
37	9000	0:05	0:08	35		6.3	3.0	260
38	10,000	0:07	0:48	39		6.7	...	390
39	10,400	0:10	1:14	24		6.6	4.0	350
40	12,000	0:04	No start	30	0:51	6.3	3.0	315
41	13,600	0:14	3:06	38	....	6.7	3.4	380
42	14,000	0:43	No start	No record	7:00	6.3	3.8	300
43	23,000	0:12	No start	21	2:08	6.3	3.7	440
44	24,000	0:12	1:31	27	....	6.3	3.7	390
45	24,000	0:11	No start	25	2:27	6.4	3.8	410
46	25,000	0:04	0:42	30	....	6.3	3.8	355
47	25,000	0:10	No start	22	1:50	6.4	3.0	400
48	30,000	0:13	No start	20	1:35	6.2	3.2	465
49	30,000	No fire	No start	10	1:39	6.4	3.4	340
50	30,000	0:08	No start	18	0:48	6.1	3.4	420
51	30,000	0:08	No start	21	1:45	6.3	3.1	390
52	31,000	No fire	No start	19	0:39	6.4	3.4	360
53	35,000	0:17	No start	26	1:27	6.4	3.6	400
54	40,000	0:37	0:50	20	....	6.4	3.2	410
55	40,000	No fire	No start	12	0:45	6.4	3.4	500
56	40,000	0:20	No start	13	1:39	6.3	3.4	370
57	45,000	No fire	No start	8	0:58	6.1	2.5	370
58	47,500	No fire	No start	14	0:32	6.0	2.7	415

* Tests conducted on Jan. 19, 1940.

Table 2 – Viscosities of SAE 10W and Proposed SAE 5W Oils at Different Temperatures

Oil	Viscosity Index	Viscosity in Saybolt Universal Seconds at Temperatures of:			
		—20 F	0 F	100 F	210 F
10W	100	50,000	12,000	191	46
10W	100	23,000	6,000	133	42
10W	0	63,000	12,000	130	39.5
10W	0	27,000	6,000	98	37.5
5W	100	11,000	3,200	100	39.3
5W	100	5,500	1,800	79	37.5
5W	0	12,000	3,200	82	36.8
5W	0	6,000	1,800	69	35.7

below-ignition needs. The starter effort to overcome friction resulting from high oil viscosity caused the battery drain.

The other three cars in the third group not producing explosions had high enough voltage for ignition; but the high-viscosity oil reduced cranking speed to a point where carburetors and induction systems didn't supply satisfactory explosive mixtures.

Since 10W is unsatisfactory for starting at this low temperature, what are the viscosity requirements of a sub-zero oil with good starting characteristics? According to Subcommittee B of the SAE F & L Technical Committee, this proposed lubricant should have viscosity limits such that its viscosity at —20F is that of 10W at 0F. The group suggests limits between 1800 and 3200 SUS at 0F. With these limits, oil ranging from 0 to 100 viscosity index would have a minimum viscosity of 6000 and a maximum of 12,000 at —20F.

Table 2 gives data on which these values are based. Fig. 1 compares viscosities of the 10W and proposed SAE 5 or 5W oils.

If the tests just discussed are any criterion, use of the new light-grade oil can spell the difference between start and no-start in sub-zero driving. But note that even use of proper-viscosity oils will not entirely solve the cold-starting problem. Indifference to instruction book recommendations, lack of preparedness and carelessness will always be with us. And even the energy available from a fully-charged battery at low temperatures may limit starting.

The instruction book recommendation that 10W be diluted with 10% kerosene for starting at sub-zero temperatures is satisfactory technically, but it is very difficult to follow this recommendation in practice. The main objection is that the mixture is unstable viscositywise. The diluent – kerosene – evaporates during driving, gradually increasing the viscosity of the crankcase lubricant. A second objection is that drivers adhering to instruction book practices will find kerosene practically unavailable at service stations.

Results of Continental Oil Co. tests point up the merits of low viscosity in a light-grade oil as against its equivalent obtained by dilution. In this case a 10W oil plus 10% dilution was compared with an undiluted oil of equivalent viscosity.

Road tests were run in 1940 on Plymouth, Ford, and Chevrolet cars under spring temperature conditions of 50F – a severe condition from a viscosity stability standpoint, but possible in cold areas during the winter. In these tests the crankcase oil temperatures under these conditions were determined.

Dynamometer test results, in Table 3, show considerable loss of kerosene dilution in a short time under these conditions simulating severe winter operating conditions. Resulting oil viscosity reached such high value as to make sub-zero starting well-nigh impossible. But the undiluted oil maintained its viscosity with little change.

While this light-grade oil does appear to assure

Discussers Debate Light-Oil Proposal

Consensus of discussion

By Carl O. Tongberg

Standard Oil Development Co.

(Chairman of Session)

IN the discussion at the meeting, advantages of a so-called SAE 5 oil from a cold starting standpoint were recognized, although it was felt that other factors such as battery and mechanical conditions were also quite important.

The actual necessity of a so-called SAE 5 oil was questioned, particularly since 10W oil has given generally satisfactory winter starting characteristics for a number of years and it has not been felt that a serious problem exists. It was also believed that an SAE 5 oil would be a small volume product and would complicate lube oil marketing.

There was considerable concern that service difficulties might be encountered through misapplication of the oil, such as use in high-speed highway operation or in truck operation.

It was generally agreed that additional work was necessary to determine the performance characteristics of so-called SAE 5 oils. Since preliminary data indicated relatively high oil consumption with these oils, further tests would be required to establish the price paid in higher oil consumption for better winter starting characteristics. Considerably more data on oil stability and engine wear when using these light oils was believed necessary. If so-called SAE 5 oils should give significant trouble from the standpoints of oil consumption and engine wear, consumer complaints might be serious and would outweigh low temperature starting advantages. Under these conditions the desirability of marketing a light oil was questioned.

The possibility of using these light oils in fluid transmissions was discussed. Although this proposal has some merit, considerable research and development work would first be necessary.

dependable cold-weather car operation, it also carries with it the penalty of higher oil consumption. Comparative hot-weather tests in a 6-cyl car showed oil consumption with the light-grade lubricant to be 40% higher than with 10W. But as Table 4 shows, the consumption is still within reason.

In two 1000-mile runs consisting of home-to-office-and-back daily driving, one of our engineers using his personal car reported the following results:

- Light-grade oil consumption – 1200 mpg;
- SAE 10W oil consumption – 2100 mpg.

Here the light-oil consumption rate was 75% greater. But smaller differences in oil consumption rate are anticipated between these two types under winter operating conditions.

Oil consumption may be higher with the proposed 5W oil, but not so engine wear rates. A CRC L-4 test, using the same oil as in the consumption rate tests together with an approved 2-104B addition agent, produced an exceptionally clean engine and very low wear measurements.

Fig. 2 pictures the results. Tool marks on the rings and cylinder bore were still plainly visible; the bearings were in perfect condition.

All these Chrysler and General Motors tests show much promise for a stable lubricant with viscosity characteristics suited to sub-zero operation. It is believed such an oil holds the answer to cold-weather starting and lubrication problems. But the situation calls for further investigation to confirm the reported findings.

Table 3 – Dynamometer Test Results Comparing Diluted SAE 10W and a Light-Grade Sub-Zero Oil

	Diluted Oil* Viscosity		Undiluted Oil Viscosity	
	at 100 F	at 210 F	at 100 F	at 210 F
Viscosity of undiluted oil	178	....	97.5	39.25
Viscosity of oil as used in test	108.5	40.3	97.5	39.25
8 hours	147.9	43.1	93.0	30.0
16 hours	153.9	44.0	95.0	39.3
24 hours	151.5	43.7	95.3	39.0
36 hours	155.8	44.0	97.9	39.5
46 hours	153.3	43.9	95.7	39.5
56 hours	155.0	44.1	96.4	39.5
67 hours	157.0	44.2	98.3	39.7

* SAE 10W with 10% kerosene dilution.

Table 4 – Light Oil Economy Test in 50-mph Country Driving

Oil Grade	Oil Mileage	Viscosity at 100 F SUS	Viscosity at 210 F SUS	Neutrality No.	Oil Consumed	Rate of Oil Consumption
10W	0	183.4	45.5	....	....	....
10W	2007	178.2	45.4	0.40	94 oz	2480 mpg
Light*	0	75.8	36.7	....	...	....
Light*	2001	86.2	37.7	0.55	149 oz	1550 mpg

* The oil grade is within the viscosity limits proposed for SAE 5 or 5W.

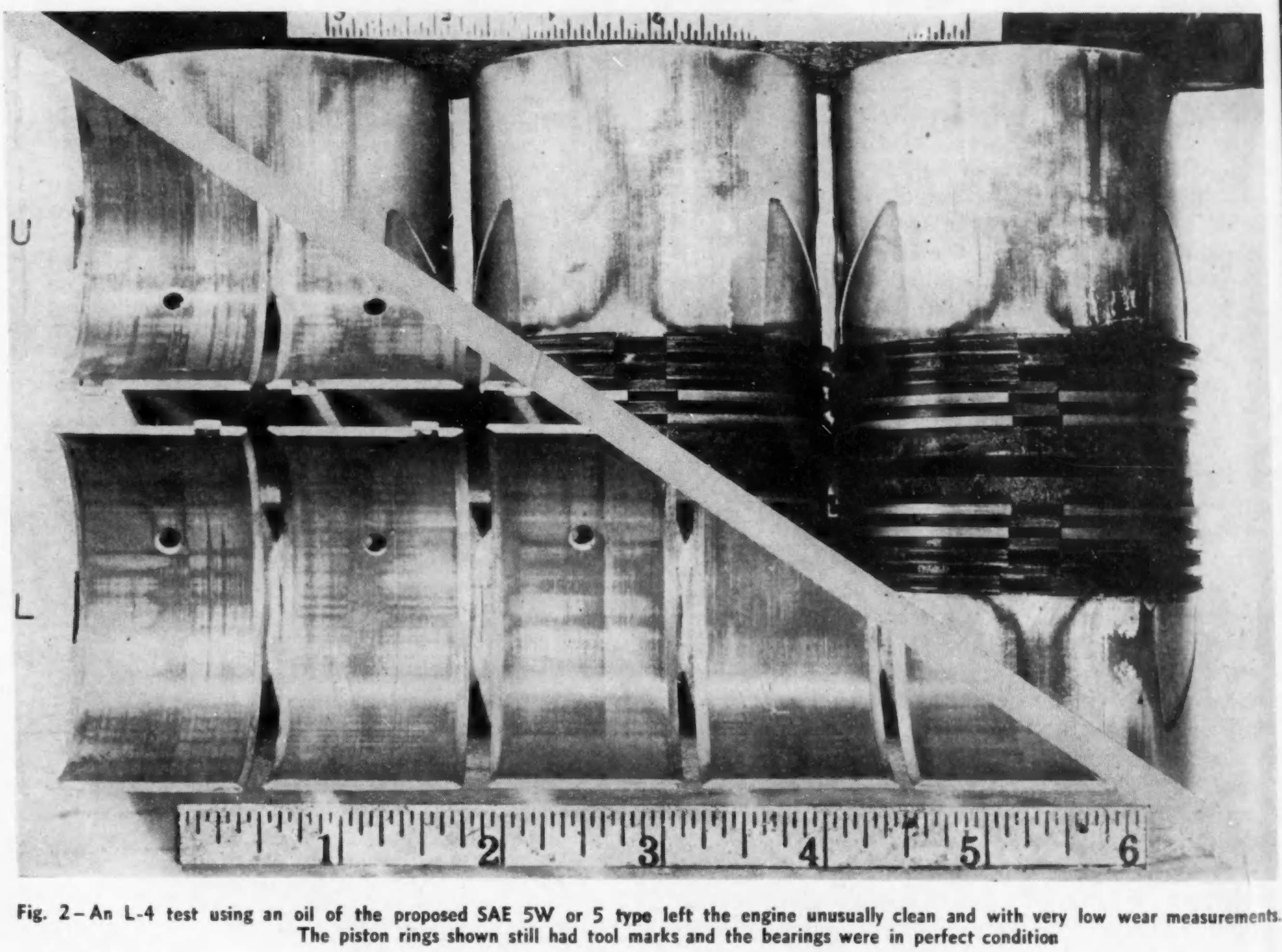


Fig. 2 – An L-4 test using an oil of the proposed SAE 5W or 5 type left the engine unusually clean and with very low wear measurements. The piston rings shown still had tool marks and the bearings were in perfect condition

DESIGNING to Reduce Airplane Noise

BASED ON PAPERS* BY

W. E. Burnham
Staff engineer, Beech Aircraft Corp.

H. L. Ericson,
Research engineer, Douglas Aircaft Co., Inc.

J. M. Picton,
Chief Planning Engineer, City Plan Commission of Kansas City

THE airplane designer's first line of attack on the noise problem should be reduction of noise *at its source*. Reduction of noise generated by propellers, exhaust, engines, and other components adds to the comfort of both the man on the ground and the man in the plane.

Of course, not all airplane noise can be eliminated at its source. The bad effects of remaining noise must be minimized by separating noise from listeners.

These are among the interesting ideas to be drawn from these three papers dealing with different aspects of the airplane noise situation.

W. E. Burnham and H. L. Ericson agree that the worst offenders on the noise score are the propeller and the exhaust system. Their noise affects people on the ground and passengers in the plane. Engines, projections on the fuselage, ventilating systems, and various accessories also contribute to the total noise heard by the passenger.

Separation of noise from the man on the ground and from the man in the plane requires different techniques. The problem in the first case is to increase the distance between the listener and the plane, especially during take-off and landing. J. M. Picton suggests that one way to do this is to coordinate design of planes and airports toward the goal of enabling planes to maintain greater altitude over residential districts bordering the airport. In the case of the man inside the plane, application of proper acoustical insulating and absorbing materials to the cabin is Ericson's answer to the noise problem. The old ear-stuffing technique brought up to date and applied to the plane instead of to the passengers can keep a large portion of the noise outside the cabin.

Almost every feature of airplane design offers opportunities for cutting down noise. Sources of noise are:

1. Propellers
2. Exhaust
3. Engines
4. Aerodynamic and Ventilating Effects
5. Miscellaneous Accessories

1. Propellers – Propeller noise consists mainly of two components: the rotation note, which has a frequency equal to the number of rotations per unit time multiplied by the number of blades in the propeller; and the vortex noise, which has a very complex frequency spectrum ranging upward from 1000 cps.

The rotation sound is a fundamental note – a low-pitch roar – accompanied by a number of harmonics. Usually there is more acoustical energy in the fundamental note than in all the other frequencies. With propellers turning at conventional speeds, the low-pitch roar is the chief cause of propeller noise. Its intensity is greatest just aft of the plane of rotation of the propeller disc.

The vortex noise is caused by the vortices formed

* Burnham paper, "Reduce Airplane Noise Through Basic Design," was presented at the SAE National Aeronautic Meeting, Los Angeles, Calif., Oct. 10, 1947. Ericson paper, "Problems of Noise Reduction from an Airplane Design Standpoint," and Picton paper, "Importance of Noise Reduction in Airport Location and Layout," were presented at SAE National Air Transport Meeting, Kansas City, Mo., Dec. 2, 1947.

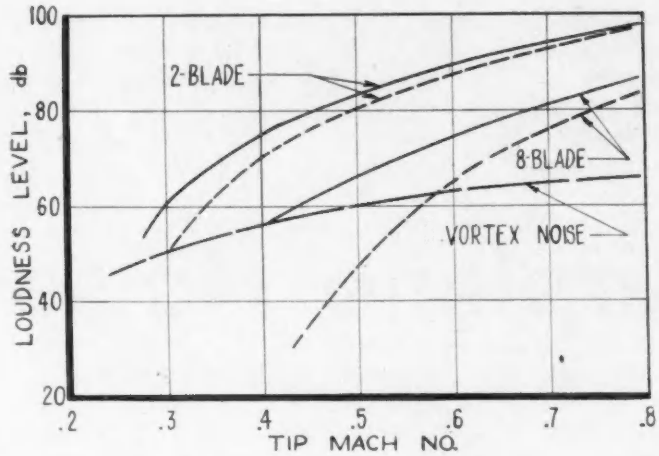


Fig. 1 – Loudness level of 2-blade and 8-blade propellers as measured at distance of 300 ft
——— total noise
– – – rotation noise

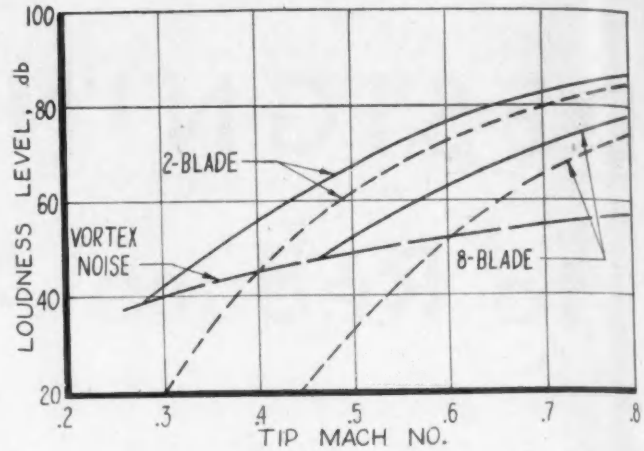


Fig. 2 – Loudness level of 2-blade and 8-blade propellers as measured at distance of 1000 ft
——— total noise
– – – rotation noise

in the turbulent air and shed off the propeller blades. Intensity of vortex noise is a function of thrust. Maximum intensity occurs along the axis of propeller rotation.

Ericson points out that the greater the minimum clearance between the fuselage and the propeller tip, the less the noise, although the effectiveness of tip clearance falls off rapidly beyond 12 in. of separation. Beyond 18 in. of separation, very little is gained.

Early studies of propeller noise indicated that slow-turning fan-type propellers would be inaudible at 300 ft. These studies neglected vortex noise, however, Burnham notes.

Comparison of 2-blade and 8-blade propellers for personal planes shows that, while rotational noise is less for the 8-blade propeller, vortex noise is the same for both. Figs. 1 and 2 show the results for propellers of 6-ft diameter. At a distance of 300 ft and a tip mach number of 0.28 (corresponds to 1000 rpm at standard sea level conditions) the 2-blade propeller is only 3 db higher than the 8-blade propeller. At a distance of 1000 ft, only the vortex noise is heard, so that the propellers are equally loud.

Figs. 1 and 2 indicate that to reduce noise, the important thing is to reduce tip speed and that the number of blades is not important, at least at the propeller speeds used with small planes.

These considerations about factors in propeller noise suggest a slow-turning, 2-blade, large-diameter propeller. According to Burnham, it can be shown that such a propeller will also be satisfactory from the standpoints of propulsive efficiency, static thrust, climb, and weight – at least at moderate airspeeds.

2. *Exhaust* – Like most vibration noise, the total noise spectrum of the exhaust consists of a fundamental note, containing most of the energy, plus harmonics of the fundamental. In designs where propeller noise is louder than the exhaust, very little is gained by muffling the exhaust. On the other hand, if propeller noise is reduced, something must be done to quiet the exhaust.

Exhaust noise does exceed propeller noise in transport planes where short stacks direct exhaust against the cabin. On the DC-6, exhaust noise was minimized by locating exhaust exits on the outboard sides of nacelles at points chosen to give maximum acoustical shielding. The system utilizes an estimated 75% of the maximum available exhaust thrust.

Noise is less of a problem in airplanes where passenger quarters are remote from propellers, exhaust, and other noisy components.

Exhaust excitations may be involved in audible beats – intermittent noises caused by the combination of two noise components of almost equal frequency and intensity.

Propeller-exhaust beating is due to the effect of the reduction gear. Harmonics of the propeller frequency may combine with harmonics of the fundamental exhaust frequency, when the intensities are essentially equal. The condition can be cured only by changing the frequency of one component, or by reducing drastically the intensity of one component. Exhaust collector rings, which tend to suppress exhaust noise, are an effective means of avoiding beats by reducing intensity.

One engine-propeller combination considered for the DC-6 gave an extremely objectionable beat. With an R-2800 engine, a 0.45 gear ratio, and a 4-blade propeller, beating occurred between the eleventh exhaust harmonic and the third propeller harmonic. Substitution of a 3-blade propeller remedied the situation, Ericson reports.

Actually, engine-propeller beating is rare, although many beating frequency combinations exist. The exhaust component is seldom of sufficient intensity to match the propeller component.

Beating sometimes develops with multiengine planes between two engines operating at slightly

different speeds. Synchronization of the engines will eliminate the beating.

3. *Engine* – Frequency of engine noise depends on engine arrangement – the frequency of the fundamental note corresponding to the frequency of the gas explosions.

Theoretically, engine noise would increase with power at the rate of 3 db for each doubling of power. In practice, noise is found to increase between 5 and 6 db for each doubling of power.

4. *Aerodynamic and Ventilating Noises* – Aerodynamic noise increases with airspeed and decreases with increasing weight of fuselage plating. Doubling the plating weight reduces noise by 6 db.

Aerodynamic noise (other than that of the propeller) and ventilating noise has already been reduced to unimportance in modern large aerodynamically clean aircraft. Many light planes, however, are still designed with such parts as struts and steps outside the fuselage where they contribute to aerodynamic noise. Elimination of such projections results in a quieter airplane.

On any plane, doors should be constructed rigidly so that when they are closed, there will be no noisy air leaks. Even though leaks do not seriously increase the noise level, the noises which they produce are particularly annoying to cabin occupants, Burnham reminds designers. Ventilating air ducts are effective speaking tubes. In the DC-6, it was necessary to install acoustical filters in the ventilating ducts to eliminate the transmission of offending noise frequencies.

Ducts should be designed to absorb vibration caused by air passing through. Air velocities should be kept low. The length-area ratio of the duct should be one which avoids the organ-pipe effect.

5. *Miscellaneous Accessories* – Many of the lightweight, fast-turning accessories on the modern airplane are highly efficient noisemakers. Such accessories as fans, water pumps, expansion turbines, and autopilots may cause considerable vibration noise, requiring vibration isolation and local application of acoustical absorbing materials.

Vibration noises from loosely fitting metal parts, such as ash trays and seats, are particularly irritating to passengers. Proper design can minimize rattles, but careful maintenance is the key to the situation.

Reduction of noise from all five sources deserves the designer's attention just as safety, weight, cost, and the other usual considerations do.

Protecting the Man on the Ground

The designer who seeks to lessen the noise nuisance of personal planes will do well to watch developments in landing gear, says Picton, as well as in the quieting of other components. Recent announcements on the successful use of castered landing gear promise that planes will someday be designed for cross-wind landing.

When planes can land without regard to wind direction, they can operate out of an airport having a single runway instead of the usual multidirectional pattern. Then, savings in construction costs of new airports could be applied to the cost of more land for a longer field.

With the longer field, planes could afford to maintain greater altitude over residential neighborhoods in the vicinity of the airport. There would be more distance between planes and listeners on the ground, so that noise would disturb residents less.

Reducing Cabin Noise

Proper acoustical treatment of the cabin will do for the passenger what distance does for the man

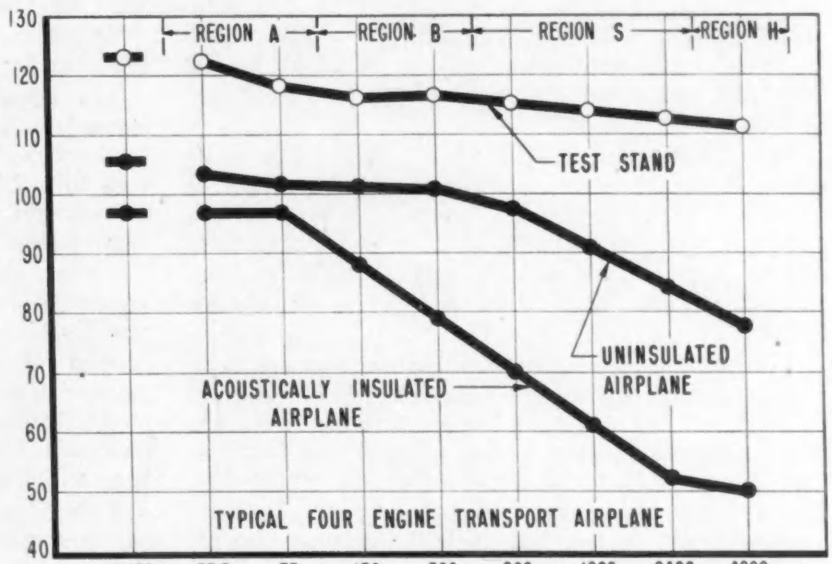


Fig. 3 – Three noise spectra for 4-engine airplane. Region A is propeller noise; Region B is exhaust noise plus higher harmonics of propeller noise; Regions S and H are propeller, exhaust, aerodynamic, and engine noise

on the ground. The extent of the treatment needed depends on what sort of sound spectrum the passenger expects.

Ericson believes that, in modern transport aircraft, passengers may reasonably expect that the cabin noise spectrum will permit easy conversation with other nearby passengers, that the noise will be free of irritating and annoying characteristics, and that it will not be uncomfortably loud. Pilot and passengers of personal planes will generally accept a less desirable noise spectrum, but builders of some of the latest personal planes have reduced noise levels and found it profitable.

It is mainly the noise in the three octaves from 600 to 1200, 1200 to 2400, and 2400 to 4800 cps that limits the ease with which passengers converse. Noise in this frequency range masks the voice frequencies which make for intelligible speech. An average value of 71 db for these three octaves permits satisfactory conversation between passengers over a distance of 12 in. A level of 61 db is satisfactory over a distance of 36 in.

Most irritating are the rattles and intermittent noises. High-frequency noises are more irritating than low-frequency noises. Passengers do not consider the low-frequency hum of the propellers annoying, even though it is the most intense component of the noise spectrum in most cases.

Noises whose intensity varies – particularly beating noises – are more annoying than steady noises of the same frequency and intensity.

Loudness is a matter of subjective judgment of the listener. Tones of different frequencies and equal intensities are not judged to be equally loud. A noise judged uncomfortably loud would probably be irritating and would interfere with speech as well.

The subjective difference between insulated and uninsulated cabins as experienced by the occupants is greater than would be expected from the measured difference in overall sound levels. The reason is that insulation is particularly effective in the 600-4800 cps region. Fig. 3 shows the measured differences.

Ericson explains that the basic element in most acoustic structures is a soundproofing blanket of glass wool. The extreme fineness of the glass filaments makes the material light in weight. Besides having high acoustical efficiency at high frequencies, the glass wool does not burn or absorb moisture.

Although low-frequency noise causes less subjective annoyance to the passenger, it should not be neglected. A sheet of impenetrable material is more effective in attenuating transmitted low-frequency sound than the same weight of glass wool. The impenetrable layer will not only cut down on low-frequency noise, but it will increase the efficiency of the glass wool at high frequencies.

A flexible mica sheet, in addition to the impenetrable layer, will increase the attenuation of the fuselage skin panels two ways. The mica adds mass, and it reduces transmission of sound at the resonant frequencies of the panels. The second effect is particularly useful, because any undamped panel has a number of resonances at which sound passes through the panel freely. The laminar construction of the mica provides damping for the panel.

Even with the best available insulation, some noise will enter the cabin. Therefore, the interior design should allow for a considerable area of sound-absorbing material.

CHALLENGE TO ENGINEERS

cont. from page 23

what-not. I think the young men who have imagination and curious minds should be placed in our research laboratories and given a chance to see what they can come up with. Certainly, I am not recommending that this be done indiscriminately, but on a selective basis.

I think more scientists should be induced to come from their teaching professions to the laboratories of the parts manufacturers and the automobile manufacturing companies. We hear now that the gas turbine engine will probably not ever be used in an automobile. I should say that in its present shape and form it may not be used in an automobile, but I think any person who says that the same principle will not some day be adopted in an automobile engine has a mind that is closed to progress.

We need our older engineers, who have the know-how and experience to sift out the practicable ideas from the crackpot ideas. But we need, too, the younger engineers more than ever in the automotive industry and we need to give them their heads.

I know that the new devices department of each automobile company receives thousands of ideas and inventions each year which have to be discarded for every one that can be used. They may go up a thousand blind alleys but if they come out on one highway with some performance-increasing, cost-reducing idea, it still will have been worth the time and money.

This is the time when bold resourcefulness and brilliant conception on the part of the automotive engineers is our greatest need. The public expects real improvement from you and I hope that they are not going to be let down.

TECHNICAL COMMITTEE PROGRESS

SAE TECHNICAL BOARD

J. C. Zeder, Chairman

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R. M. Insley	R. L. Weider
G. W. Laurie	D. K. Wilson

V. C. Young

SAE Engineers to Probe Surface Finish Standards

The SAE Technical Board recently authorized a study attacking the inadequacy of master surface finish blocks for determining and specifying surface roughness. This action stems from recommendations of an SAE exploratory group on the subject. The group also reported that specifying roughness without surface character confuses finish identification.

Production engineers find current so-called standard finish blocks belie their name. First, many of the blocks are not alike. Second, the surface on any one block may vary widely from point to point. This makes for confusion and limits their use, particularly in the automotive industry.

These engineers agree on the need for a truly-standard set of master blocks. The SAE Technical Board plans to explore the problem. Viewpoints thus developed will be submitted to American Standards Association Committee B-46, now preparing a surface finish block standard.

Achieving the standard block would allow specification of roughness measurement; but the Committee warns of its shortcomings as sole criterion of surface finish. Surface character is just as important. Both roughness and character must be specified to identify the surface correctly.

Specifications under development by various companies and technical groups designate roughness alone. This exists because present instruments can measure roughness only in terms of root mean square value in microinches.

But here's the trouble with this approach: Roughness may indicate surface suitability for a particular application only for one machining

process – such as surface grinding. It doesn't hold for a case such as two surfaces, both with a root mean square value of 20 microinches, one produced by diamond boring and the other by light and heavy honing.

They may differ entirely in satisfying a given use.

This investigation turned up another related factor. Dimensional accuracy needs consideration if surface finish specifications are to be determined properly.

Authors of the report cautioned against a current move to specify a particular finish for a specified part. They feel surface finish technology is not yet sufficiently advanced to make this practicable. Variations in load, speed, and lubrication permit many different roughnesses and surface characters for the same component. This is evidenced by the widely varying surfaces on cylinder bores and crankpins specified by manufacturers today.

This Committee also found certain surface finishes influence fatigue strength. But it recommended omitting this angle from specifications until more data is accumulated.

The SAE Surface Finish Project Committee that surveyed the problem was headed by Gustaf Carvelli, Wright Aeronautical Corp., and included Clayton Lewis, Chrysler Corp.; F. R. McFarland, Packard Motor Car Co.; A. C. Richmond, International Harvester Co.; C. L. Stevens, Ford Motor Co., and A. F. Underwood, Research Laboratories Division, GMC. J. M. Crawford, General Motors Corp., was Technical Board sponsor.

Seek Data On Alloy Supplies

MORE and better information about available stockpiles of essential steel-alloying elements is being sought by the Executive Committee of the SAE Iron and Steel Technical Committee.

Receipt of information that loss of foreign supply sources could bring America's gigantic steel manufacture to pigmy size unless good foresight is used has resulted in decision to rely on the Committee's own Panel A and the SAE-AISI Liaison Committee to develop additional vital alloys supply data.

The study-stimulating information was quoted to the Executive Committee by Committee Chairman G. C. Riegel, Caterpillar Tractor Co.

There isn't enough manganese presently available, the Committee was told, to add 1 lb per ton, let alone the 10 lb per ton needed to raise American steel production to the much-talked-about goal of 100,000,000 ingot tons per year. Other facts brought out that:

- United States uses 52% of the world production of chromium – and produces about 2%;
- We import 66% of our tungsten requirements and normally consume about 33% of world production;
- There are not sufficient reserves of tungsten, chromium, columbium, and cobalt in the United States to run a wartime jet-engine program for 30 days;
- Aluminum needed in steel manufacture represents about 4% of our annual aluminum production; we are today importing from South America a large share of aluminum ore used;
- United States' consumption of tin is about 55% of world production. We contribute about 0.02%.

Chart Aero Stud Standard Criteria

SAE's Aircraft Screw Threads Committee laid down basic musts for the truly-effective engine stud standard it plans to develop.

These engineers feel the long-awaited, but never quite-achieved, stud standard will satisfy industry needs only when it gives:

1. Data on male stud including oversize, pitch diameters, and increment-in-length information;
2. Internal thread data;
3. Specific lubrication information;
4. Positive recommendations for identification;
5. Driving torque data;
6. A separate parts standard for studs.

Although SAE has developed a recommended practice on aircraft studs (ARP 142, Stud Fits and Tolerances – Steel in Aluminum and Magnesium Alloys), this group finds it inadequate and not sufficiently specific. It presents too many alternatives.

The conferees are shooting for a true standard, not a guide or informational document. It will clearly define one stud only based on sound technical judgment and industry practice. Most engine companies specify specialty stud features. But Committee members are prepared to make compromises to achieve their goal.

The Committee is also considering high-temperature stud use, particularly in gas turbines. Preliminary extreme-cold soaking was suggested as one way to facilitate permanent stud installation. Chairman Gustaf Carvelli, Wright Aeronautical Corp., reported little success for this method in his company.

Other fastenings – such as bolts and cap screws – were suggested before trying studs in steel for high-temperature work.

New SAE Aero Meanings

FIVE aeronautical specifications released last month by SAE define airplane engine nomenclature; outline proper preservation and packaging techniques; deal with propeller shaft bearings; and specify minimum performance for airplane instruments.

The new specifications are:

• Nomenclature Guide for Aircraft Engine Parts

Aeronautical Recommended Practice ARP 143A is a revision of an earlier SAE nomenclature guide. It now contains new terms added to the technical language by turbojet and turboprop engines. New piston engine terms were added, others were clarified.

This ARP defines each engine part so that it can't be construed for any other. It aims to eliminate ambiguity and lack of uniformity in the meanings of these often-used parts names.

Need for a standardized nomenclature is more urgent than apparent. It is important in titling drawings, in stock lists and parts catalogues. It makes for accuracy in supplier-user relations. Most engine makers retitled their drawings in conformance with the SAE nomenclature guide.

Nearly 600 terms are defined, starting with "accessory" and ending with "yoke."

• Preservation and Packaging of Aeronautical Parts and Accessories

Newly-developed Aeronautical Recommended Practice ARP 197B sets forth economical methods of preserving and packaging aeronautical parts. It replaces costly wartime practices required for military operations with practical techniques for commercial use.

The military had to take utmost precautions. The same part might end up in the tropics or the arctic. It required protection against both climatic extremes.

The new document specifies two methods for protecting the part, one for domestic and the other for export shipment. While less costly, the current preservation and packaging techniques recommended still insure against damage in shipping and storing.

Now the manufacturer and airline operator know where and how the part is to be shipped. They can select the appropriate treatment. They need no longer give the part the "works" to cover every possible contingency.

ARP 197B also points out proper depreservation procedures. This is as important as the preservation process

Specs Clarify Methods, and Musts

itself. Improper removal of preservative compounds may ruin the part as quickly as the absence of them.

For this reason airlines with overseas operations will find the new specification especially helpful. They can now ship parts to overseas depots together with the specifications for proper depreservation. This was not always possible with military specifications because of government restrictions.

The specification itself contains two basic charts. The first outlines by part type, the method of preservation, preservative, and outer wrapping. The second one describes these preservative and wrapper materials and their uses. It gives equivalent Army-Navy specifications—if any.

Fig. 1 shows the wrapping recommended for extensive storage or hazardous shipping conditions.

Preservative compound specifications referred to in this document were prepared by Subcommittee S-6B, Preservatives and Humidity Cabinets Testing. Subcommittee S-6C, Moisture Barriers, developed those on wrapping materials. (See article "Supplier-User Efforts Spur Parts Packaging," p. 75, December, 1947, SAE Journal.)

• Propeller Shaft Ends – Dual Rotation (Engine-Supplied Bearings)

Investigation proved an engine-supplied bearing complicates lubrication of dual-rotation propeller shafts, says Aeronautical Information Report No. 18.

Here's why it doesn't work: The engine supplies a bearing the propeller must seal and lubricate. It can't be done satisfactorily. And the nature of the design renders the plan impractical.

Dual-rotation propellers have extremely long outboard shafts. The bearing should be near the outboard end of the inboard shaft for two reasons: (1) for support and (2) to prevent contact between shafts under some operating loads. Supporting both shafts on a bearing within the engine does neither.

The report recommends a propeller-supplied bearing specified in SAE Aeronautical Standard AS 91. For the record, it also presents dimensions and requirements of the advised-against engine-supplied bearings.

• Air Speed Tubes, Electrically Heated

Aeronautical Standard AS 393 spells out minimum performance requirements for electrically-heated air-speed tubes.

It specifies performance under varying environmental conditions such as temperature and vibration. The instrument must also comply with specifications under individual performance tests – leakage, dielectric, heater operation, and calibration.

• Fire and Heat Detectors

Minimum performance requirements outlined in Aeronautical Standard AS 401 are designed to insure safe and reliable operation of fire and heat indicators.

The instrument must not give false signals because of voltage variations, change in flight attitude, or flight and landing accelerations. It must withstand vibration and outside temperature and humidity changes to function properly. The detector must warn the pilot of any undue heat rise in engines, auxiliary powerplants, or heaters.

Both of these standards, AS 393 and AS 401, were requested by the Aircraft

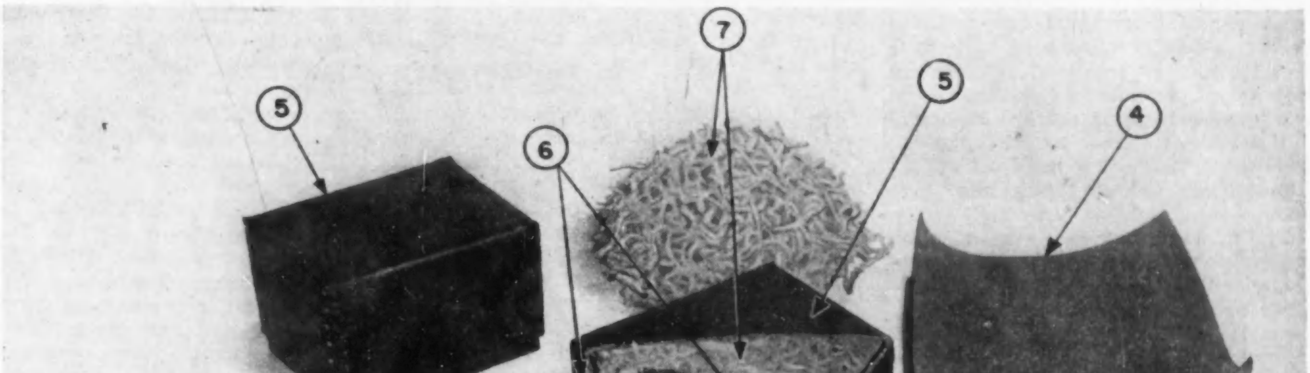

Fig. 1 – This is how to package a part for extensive storage or hazardous shipping conditions, according to the techniques recommended in the recently-released ARP 197B. The gear (1) is given a conforming wrap and wax dip. The packaging consists of: (2), heavily-waxed, noncorrosive greaseproof paper, AMS 3542; (3), same material as (2) for additional over-wrap on gear teeth; (4), noncorrosive greaseproof paper, AMS 3540, next to the part; (5), chipboard unit carbon; (6), labels attached to part and to carton exterior; (7), nonhygroscopic dunnage for cushioning. Part is shown completely wrapped in (8)—first in item (4) and then in item (2). It's then completely wax dipped in microcrystalline wax sealer

Industries Association for reference in Technical Standard Orders issued by the Civil Aeronautics Administration. (For details of new CAA instrument-approval plan, see article "New Instrument Standards Speed CAA Clearance," pp. 61, 62, September, 1947, SAE Journal.)

SAE Hydraulic Specs To Fight Plane Fires

SAE's contribution toward freeing aircraft from fire hazards is taking the form of minimum performance specifications for fire extinguishers and studies of nonflammable hydraulic fluids.

The airlines feel a small hand-type water-solution fire extinguisher would serve for possible cabin fires. It should be one a hostess could use to put out fires such as those caused by a burning cigarette.

At present it's visualized as about a 1⅝-qt size unit designed for one-hand operation. This extinguisher probably would have a replaceable cartridge containing a water-solution fluid under pressure.

A. H. Hobelman, Walter Kidde Co., has contacted all fire extinguisher manufacturers for recommendations for a performance specification. At a recent meeting of SAE Committee A-6, Aircraft Hydraulic and Pneumatic Equipment, attended by all interested extinguisher manufacturers and airline operators, agreement was reached on a preliminary proposal. It will include items such as extinguisher size and performance.

The draft is now being readied for industry-wide circulation.

Recommendation that SAE undertake this job came from the Air Transport Association and Aircraft Industries Association, which plan to submit the completed specification to the Civil Aeronautics Administration for reference in CAA Technical Standard Orders.

Nonflammable Fluid Progress

Study of performance specifications for nonflammable hydraulic fluids is another phase of SAE Committee A-6's work aimed at elimination of fire dangers. Chairman B. R. Teree, The Weatherhead Co., advises that the SAE Committee is keeping close contact with researchers on such products now under way at three different agencies – the Aircraft Industries Association, the Air Force, and the Navy.

An AIA committee has drafted a proposal covering an interim fluid for commercial aircraft. But this group recognizes the development of a completely nonflammable fluid as a long-range problem. Apparently there is no immediately available source of supply to meet even this interim specification, although a source is expected in the near future.

An Air Force research project at Purdue University on fluerocarbon type of hydraulic fluid is expected to yield a definitely improved fluid within the next year. Present data show this material to be promising from both nonflammability and low-temperature operation standpoints.

Navy research also has evolved a promising fluid known as Hydrolube U4. It has no phosphate inhibitor, but does contain a new corrosion inhibitor. The base polymer is the same as in the original Hydrolube U.

In flight tests this material has performed satisfactorily in a 3000-psi system for over 450 hr. The Navy believes the fluid will be acceptable for temperatures of 160 to 180F. It plans to use the new fluid in all experimental and service aircraft through a gradual direct replacement program.

The CAA and Civil Aeronautics Board are watching closely all new developments in the field.

Work on Hydraulic Hose Specs

Specifications for high-pressure hydraulic flexible hose is another project under SAE cognizance. Military services, airplane manufacturers, and airline operators need a satisfactory flexible hose for 3000-psi systems – which they feel is not yet available – and are willing to pay more than the present hose price.

Reports have come to the Committee detailing chronic hose failures such as inner tube failure; tube inconsistency due to failed wire braid; lack of backup devices between liner and wire braid; use of unsatisfactory or low-grade wire for braid. Most of the troubles, some hose users feel, stem from a lack of product uniformity.

SAE Committee A-3, Aircraft Valves, Fittings, and Flexible Hose Assemblies, under L. J. Henderson, Aeroquip Corp., will work with industry to come up with improved hose specifications as soon as possible.

Precision Casting Specs Under Way

WHAT the user receives rather than how the producer achieves it will guide creation of precision casting specifications planned by SAE.

An SAE Iron & Steel Technical Committee group hopes to direct its precision casting specification-making efforts chiefly to the engineer, not the foundryman. For this reason the emphasis will be on chemistry, physical properties, tolerances and methods of testing. Manufacturing methods will be given only general coverage.

Discussion of physical properties disclosed inadequacy of laboratory tests for determining them. Said one member, "It isn't the metal that's brittle, it's the shapes." Round test bars do not give the same properties as the seldom-round part itself. A test bar may be bad while the casting may prove acceptable.

Possibility of abandoning the conventional round test bar will be examined. Investment castings were said to allow specification of test bar sizes and shapes producing significant results.

Frequency of testing for chemistry, the conferees felt, should be left to purchaser's discretion. Sampling each of 40 to 60 heats poured by precision casting producers, a not uncommon practice, would be economically prohibitive. Selection of random samples from a day's heat or from each 1000 castings was suggested for smaller sizes. Operational economy, it was felt, should dictate large casting testing frequency.

Specification coverage of heat-treatment, composition, quality, and inspection methods were postponed for future discussion. The Committee needs more information and data before it can work on these sections.

This group, Division XXII, Precision Castings, will not duplicate work of other organizations active in this area. American Foundrymen's Association technical committees develop recommended practices primarily; this group will concern itself chiefly with specification writing.

But to benefit from the casting producer's experience and know-how, Division XXII will function as a joint SAE-AFA group.

Future work planned includes other types of mold and sand castings. Recent SAE Technical Board authorization places nonferrous alloys – except aluminum, copper, and zinc base types – within Division XXII's scope. Thus, high-temperature alloys such as cobalt, tungsten, and molybdenum produced by ferrous metal suppliers will be considered.

Chairmanned by R. J. Wilcox, Michigan Steel Castings Co., the membership includes E. E. Ensign, Ford Motor Co.; Kenneth R. Geist, Allis-Chalmers Mfg Co.; C. J. Tobin, Research Laboratories Division, General Motors Corp.; Gosta Vennerholm, Ford Motor Co.; W. L. Badger, Thomson Laboratory, General Electric Co.; Dorman Dickerson, Kerr Mfg. Co.; Russell Franks, Electro-Metallurgical Co.; Edward Grubb, International Nickel Co.; R. R. Kennedy, Air Materiel Command, AAF; W. Matthes, Arwood Precision Castings Corp.; H. Rosenthal, Frankford Arsenal; W. O. Sweeney, Haynes Stellite Co.; E. I. Valyi, A. R. D. Corp., and Gordon Williams, Pratt & Whitney Aircraft.

CALENDAR

of Section Meetings

Baltimore – Feb. 12

Engineers Club; dinner 7:00 p.m. Airport Operation – James H. Carmichael, president, Capital Airlines.

British Columbia Group – Feb. 9

Hotel Georgia – Ballroom, Vancouver; dinner 6:30 p.m. Meeting 8:00 p.m. Spring Suspensions in Automotive Vehicles of Today – N. E. Hendrickson.

Central Illinois – Feb. 23

Hotel Jefferson, Peoria, Illinois; dinner 6:30 p.m. Meeting 8:00 p.m. Dual Fuel Engines – Mr. Ralph R. Boyer, vice-president and chief engineer, Cooper Bessemer Company. Technical chairman – Mr. R. D. Henderson, Caterpillar Tractor Company.

Chicago – Feb. 10

Hotel Knickerbocker; dinner 6:45 p.m. Meeting 8:00 p.m. Annual meeting on tractors, industrial power and diesel engines. Social half-hour 6:15 to 6:45 p.m. sponsored by Mechanics Universal Joint Division, Borg-Warner Corporation, Rockford, Illinois.

Dayton – Feb. 24

Delco Products Division, GMC; inspection trip. Dinner 6:30 p.m. at Engineers Club.

Detroit – Feb. 16

Large Auditorium, H. H. Rackham Educational Memorial; dinner 6:30 p.m. Transportation problems on the West Coast – Mr. Ted V. Rodgers, American Trucking Associations, Inc. Sound film – Horizons Unlimited.

Kansas City – Feb. 24

Hotel Brookside, Kansas City, Mo.; dinner 6:30 p.m. Telephone Science in War and Peace – Irvin Mattick, public information supervisor, Southwestern Bell Telephone Co., St. Louis.

Metropolitan – Feb. 18

Hotel Pennsylvania; meeting 7:45 p.m. Air Transport meeting. Speaker – Hugh L. Dryden, NACA.

Mid-Continent – Feb. 6

Hotel Mayo – Junior Ball Room, Tulsa, Okla.; meeting 7:30 p.m. Review of papers given at Detroit National meeting. Motion picture – Oil for Tomorrow.

Milwaukee – Feb. 6

Milwaukee Athletic Club; dinner 6:30 p.m. Field Testing of Motor Oils and Gasoline – A. C. Pilger, Jr., Tide Water Associated Oil Co.

New England – Feb. 3

Massachusetts Institute of Technology – Campus Room, Graduate House, Cambridge, Mass. Social hour 6:15 p.m. Dinner 6:45 p.m. Meeting 7:45 or 8:00 p.m. Developments in Fuels, Lubricants, and Lubrication – SAE President R. J. S. Pigott, chief engineer, Gulf Research and Development Co.

Northern California – Feb. 21

Hotel Claremont, Berkeley, California; annual SAE dinner dance.

Fresno Division – Feb. 2 – Hotel Fresno; dinner meeting. Fuels and Lubricants for the Private Flyers – D. N. Harris, Shell Oil Co.

Northwest – Feb. 6

Hotel Gowman; dinner 7:00 p.m. The Wide Base Rim Program – Mr. W. L. Hamlen, Western Division manager, Rim Division, Goodyear Tire and Rubber Company. Power Steering – Mr. R. C. Norrie, chief engineer, Kenworth Motor Truck Corporation.

Oregon – Feb. 13

Lloyds Golf Course; dinner 7:00 p.m. Air Brakes, Air Brake Equipment; Their Operation and Proper Maintenance – Julius Gaussoin, Silver Eagle Transportation Co.

Philadelphia – Feb. 11

Engineers Club; dinner 6:30 p.m. Efficient Production and Utilization of Motor Gasoline – William M. Holaday, Socony-Vacuum Oil Co.

Pittsburgh – Feb. 24

Mellon Institute; dinner 6:30 p.m. at Webster Hall across street from Mellon Institute. The Elimination of Combustion Knock – E. M. Barber, The Texas Co. Guest – SAE President R. J. S. Pigott, chief engineer, Gulf Research and Development Co.

St. Louis – Feb. 10 and March 9

Feb. 10 – Garavelli's; Ladies Night. Games, prizes followed by buffet supper.

March 9 – Garavelli's; dinner 7:00 p.m. Cocktails 6:30 p.m. courtesy

SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
PASSENGER CAR and PRODUCTION	Mar. 3-5	Book-Cadillac, Detroit
TRANSPORTATION	Mar. 30-31, Apr. 1	Bellevue-Stratford, Philadelphia
AERONAUTIC and AIR TRANSPORT	Apr. 13-15	New Yorker, New York City
SUMMER (Semi-Annual)	June 6-11	French Lick Springs, French Lick, Ind.
WEST COAST	Aug. 18-20	St. Francis, San Francisco
TRACTOR and DIESEL ENGINE	Sept. 7-9	Schroeder, Milwaukee

FIRST POSTWAR SAE NATIONAL

PASSENGER CAR and PRODUCTION Meeting

Hotel Book-Cadillac MARCH 3-5

WEDNESDAY, MARCH 3

9:30 a.m. PASSENGER CAR

B. E. House, Chairman

Bonding Brake Lining to Shoes – W. R. Rodgers and J. V. Hendrick, Chrysler Corp.

Passenger Car Brake Performance Limitations and Future Requirements – T. P. Chase, Research Laboratories Division, General Motors Corp.

2:00 p.m. PRODUCTION

L. A. Danse, Chairman

Production Process Control – What It Can Do for Quality, Costs and Volume – R. H. McCarroll, Ford Motor Co.

Aluminum for Body Stamping – Selection of Alloys, Drawing and Joining – J. H. Dunn, E. G. Kort, and G. O. Hoglund, Aluminum Co. of America

8:00 p.m. PRODUCTION

Joseph Geschelin, Chairman

Modern Welding Procedures in Building Motor Car Bodies – E. O. Courtemanche, Briggs Co.

Development of Low Weight Forgings – J. H. Friedman, National Machinery Co.

THURSDAY, MARCH 4

9:30 a.m. PASSENGER CAR

J. H. Hunt, Chairman

Car Design Factors in Highway Safety – Maxwell Halsey, Michigan State Safety Commission

Headlighting with Minimum Glare – V. J. Roper, General Electric Co.

2:00 p.m. BODY

R. A. Terry, Chairman

Determination of Dynamic Loads in Coach Structure – W. E. Rice, and R. O. Ellerby, GMC Truck and Coach Division, General Motors Corp.

Stress Engineering as Applied to Automobile Bodies – P. O. Johnson and R. G. Heyl, Jr., Fisher Body Division, General Motors Corp.

8:00 p.m. BODY

A. R. Lindsay, Chairman

Design for Manufacturing Automobile Bodies – W. A. Graf, The Budd Co.

FRIDAY, MARCH 5

9:30 a.m. PASSENGER CAR

W. E. Lay, Chairman

Walls of Jericho – L. E. Muller, Buick Motor Division, General Motors Corp.

Vehicle Vibration Limits to Fit the Passenger – R. N. Janeway, Chrysler Corp.

2:00 p.m. PASSENGER CAR

W. S. James, Chairman

Cylinder Wear and Distortion as Measured with the Cylinder Contour Gage – M. E. Estey, Perfect Circle Co.

The Buick Dynaflow Drive – C. A. Chayne, Buick Motor Division, General Motors Corp.

6:30 p.m. .... Dinner .... FRIDAY

Robert Insley, Chairman, SAE Detroit Section
B. E. Hutchinson, Toastmaster
R. J. S. Pigott, SAE President
"Supplying the Mid-West with Petroleum Products"

ROBERT E. WILSON

Chairman of the Board
Standard Oil Co. (Indiana)

Phillips Petroleum Corp. Suspension Systems – Tore Franzen, Chrysler Corp.

San Diego – Feb. 19

San Diego Women's Club. Meeting 7:30 p.m.

Southern California – Feb. 5

Rodger Young Auditorium, Los Angeles; dinner 6:30 p.m. Meeting 8:00 p.m. General Electric Turbojet – General Electric representative from Schenectady. Films – German V-2 Rocket and White Corporal Rocket.

Southern New England – Feb. 4

Ryan's Restaurant, Hartford, Connecticut; dinner 6:15 p.m. Meeting at Avery Memorial, Hartford, Conn; 8:00 p.m. Sludge and Varnish in Automotive Engines, Their Cause and Cure – Harry C. Mougey, technical director, General Motors Research Laboratories. Guest – SAE President R. J. S. Pigott, chief engineer, Gulf Research and Development Co.

Twin City – Feb. 5

Hotel Curtis – Solarium Room, Minneapolis, Minnesota; dinner 6:30 p.m. Utilization of Chassis Dynamometers and Maintenance Record Analysis to Improve Operating Economy – H. T. Mueller, Research Laboratories, Ethyl Corp.

Washington – Feb. 10

Hotel Broadmoor; dinner 7:00 p.m. 1948 Cars and Future Trends – Joseph Geschelin, Detroit editor, Automotive Industries.

Williamsport Group – Feb. 2

The Anglers Club; dinner 6:45 p.m. Considerations in Valve Gear Design – V. C. Young, Eaton Mfg. Co.

Admiral Hussey Now Heads ASA

VICE-ADMIRAL GEORGE F. HUSSEY, JR., USN (Ret.), has been appointed administrative head of the American Standards Association effective Jan. 1, Frederick R. Lack, president of the ASA and vice-president of Western Electric Co., announced.

The Admiral, wartime chief of the Navy's Bureau of Ordnance, succeeds Dr. P. G. Agnew, who becomes consultant. Cyril Ainsworth was appointed director of operations of the ASA staff under the Admiral.

In a statement to the press, Lack said that standardization has become a major tool in the economic prosperity of the nation; he expects the program of that organization, of which the SAE is a Member Body, to expand in the fields of safety codes, building codes, dimensioning, and methods of test.

Student Branch News

Charles M. Jordan of M.I.T., holding his prize-winning automobile model

Massachusetts Institute of Technology

Charles M. Jordan (M.I.T. '49) is this year's winner of General Motors' model car contest. His winning model, which has earned him $4000 and an offer to go to work designing automobiles for General Motors when he graduates, has such design innovations as:

- Rear engine mounted on an easily-removable subchassis, to permit installation of a temporary unit while the engine is being overhauled;
- Tubular headlights that throw out a sheet of light to give wider and more brilliant illumination of the road;
- Polaroid windshield made of unbreakable plastic and mounted on a tubular frame;
- Windshield extending far enough into the roof so that driver and front seat passengers can see tops of mountains and skyscrapers, but with an adjustable shade;
- Division of sweeping fenders and doors into two panels to cut down replacement expense.
- Tail lights and other exterior accessories mounted between chrome strips encircling the front and rear fenders.

Jordan has been active in M.I.T.'s Student Branch since his freshman year, and this year is its vice chairman. At the Student Branch's Nov. 20 meeting, Jordan spoke to members about future body styles in five well-known makes of cars. With blackboard sketches, he pointed out significant additions and changes in styles of the Pontiac, Cadillac, Chevrolet, Ford, and Lincoln.

The meeting was concluded with the presentation of two films. The first, called "Modes and Motors," and prepared by GMC's styling section, emphasized the importance of industrial styling in the preparation of market products. With special reference to the automotive industry, it outlined the steps taken to convert new body styles from a sketch on an artist's pad to the reality of a new model in the dealer's showroom. "New Automobiles," a film prepared by the Automobile Manufacturers Association, brought out the intricacy of the manufacturing processes involved in the automotive industry. It indicated the long-lasting effects of the last world conflict on the industry when it converted to war production, and in this way explained the great time lag between the end of the war and reconversion.

—by Ralph H. Riedel, Field Editor.

California Institute of Technology

Caltech Student Branch members joined student members of ASME on Dec. 8 to hear an arresting and thought-provoking discussion by Harry Boller (Caltech '38), who told of the operation of his consulting engineering firm.

Eleven engineers and machinists are employed, he said, and in two years he has handled 400 jobs ranging in value from a few dollars to $20,000. Customers fall into three general categories: private individuals who need assistance; engineering firms that need special equipment; and research organizations that need aid in development projects. Customers may present their problems as completed drawings with all specifications; as general drawings and specifications which the firm must detail; or as oral descriptions of the equipment and what it is to accomplish, leaving the firm to work out methods.

Boller showed slides of some of his interesting projects:

- A rubber tube clamp, developed to meet a need for dependability in administering anaesthetics. A dual clamp finally was made that would accurately control the flow of two liquids without allowing mixing of the two at their supply points.
- An intricate speed selector and control device for pump rpm. The selector and control unit has a cone of gears turned at an accurately known speed, and this speed permits other speeds to be picked from the cone of gears. This selected speed is compared with the speed of a selsyn repeater for the actual rpm of the pump. Any difference is observed by a differential which subtracts the two speeds, and correction is made. The speed selection is made to one-thousandth of the total speed range, a remarkable flexibility. One interesting feature is that the constant frequency for the cone of gears is

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Oregon State College Student Branch members at Consolidated Freightways shops on Nov. 7

About

PETER F. HURST has been elected president of Aeroquip Corp., Jackson, Mich. He was instrumental in the organization of this corporation in 1940 and was previously its executive vice-president. Hurst is also a director and president of Eltron, Inc., Anotreat, Inc., and Metalco, Inc., all in Jackson.

WILLIAM HARRIGAN has organized the William Harrigan Co. in Rutherford, N. J., industrial engineering consultants. Harrigan, formerly chief automotive engineer with the Texas Co., resigned recently after 20 years with the company, to engage in his new work. For years he has been active on SAE technical committees.

W. HAYWARD GEDDES has been appointed chief engineer of United Aircraft Products, Inc. in Dayton, Ohio. He has been with this company for the past seven years. Before this, he had held posts with the Utilities Engineering Co., Inc., Albany, N. Y., Louden Machinery Co., N. Y., American Flange & Mfg. Co., Inc. and the Harrison Radiator Division of General Motors Corp.

A. H. TIMMERMAN, vice-president of Wagner Electric Corp. in St. Louis, has received a certificate for "fifty years of continuous service in the electrical industry" from the National Electrical Manufacturers Association at a meeting held recently in Atlantic City. He joined the Wagner company in 1899.

Until recently a draftsman with the Beech Aircraft Corp. in Wichita, Kans., **FRANK JEZEK** recently became factory representative for Merrill Engineering Laboratories in Denver, Colo.

Having served as propulsion engineer with the Bendix Aviation Corp. in North Hollywood, Calif., **ALBERT L. STANLY** is now a lecturer and research engineer with the University of California at Los Angeles.

Having served as technical representative for Ranger Aircraft Engines, **WILLIAM RUSSELL** is now employed by the W. H. Coffin Air Service in Los Angeles. He is assistant to the service manager, covering the night crews on service maintenance. **J. G. DERWINGSON** is the service manager at this company.

Recently connected with the Perfection Stove Co., Cleveland, as chief of the Automotive Products Division, **ALLEN E. CLEVELAND** is now project development engineer with the Ford Motor Co. in Dearborn.

Previously a production manager with the Dependable Products Co. in New York City, **HOWARD W. FRANK** is now chief engineer of the Fiveboro Equipment Co. in Flushing, N. Y.

WEI-SHENG WU is now an assistant professor in the Department of Mechanical Engineering at the National Peking University in Peiping, China.

FRED J. RODE is now assistant to the executive vice-president of the Warren City Mfg. Co. in Warren, Ohio. Prior to this post, he was affiliated with the Verson Co. in Toledo, Ohio.

Now a student at the Harvard Graduate School of Business Administration in Boston, Mass., **PAUL JOHN RICH** has been a test engineer for Pratt & Whitney Aircraft Co. in East Hartford, Conn.

No longer maintenance manager for the California Truck Rental Co. in Los Angles, **CHARLES W. MILLS, JR.,** is general operations manager for the Motor Leasing Corp. in Atlanta, Ga.

CAPT. WATSON AMBRUSTER, II, who is with the Air Force advisory team in Hankow, China, has been awarded, by the Chinese Government, the Mai Chi Medal for his work with them for the past year.

Now in the employ of the B. G. Corp. in New York City as a designer, **DANIEL H. SHAPIRO** had previously been a layout draftsman for Pratt & Whitney Aircraft Division of United Aircraft Corp. in East Hartford, Conn.

JOSEPH H. RICHARDS, who had been affiliated with the Twin Coach Co. in Kent, Ohio, is now an engineer with the Hercules Motors Corp. in Canton, Ohio.

GERALD E. HYNAN is now employed as a development engineer for the Central Foundries Division of General Motors Corp. in Saginaw, Mich. He had been production engineer for Jackson & Church Co., same city.

EARLE J. RAUT recently became senior mechanical engineer with the Andrew Jergens Co. in Cincinnati, Ohio.

Formerly employed in the Engineering Department at Wright Aeronautical Corp. in Wood-Ridge, N. J., as an assistant project engineer, **JOHN F. PRICE** recently became sales engineer with the Twin Disc Clutch Co., covering the Eastern District from the branch office in Newark, N. J.

Recently graduated from Ohio State University in Columbus, **MARVIN L. YEAGER** has become a machine design engineer with Battelle Memorial Institute in Columbus.

JAMES E. MIDKIFF is now general manager of the Midkiff Supply Co. in Grand Rapids, Mich. He had been production control supervisor for the Schweizer Aircraft Corp. in Elmira, N. Y.

Recently graduated from Purdue University in West Lafayette, Ind., **JOHN N. HEATER** is an engineering trainee with the Elmes Engineering Works of American Steel Foundries in Chicago.

Members

ARTHUR B. SCHULTZ recently became assistant chief engineer with the Tucker Corp. in Chicago.

Preceding his appointment as assistant to the chief chassis engineer with the Hudson Motor Car Co. in Detroit, **HARRY P. DOBROW** was head of the Analytical Engineering Department at Willys-Overland Motors, Inc., Toledo.

Heretofore a service manager with the Ford Motor Co. of Canada, Ltd., **M. P. PAUPST** recently became district manager for the Dodge-DeSoto Division of Chrysler Corp. of Canada, Ltd. in Regina, Sask. Paupst had been with Ford of Canada for 17 years, and during this time also spent two years in England as a technical representative with the British Army.

Until recently an automotive engineer with the Firestone Industrial Products Co. in Detroit, **PHILIP H. SMITH** has now become resident engineer for the General Tire & Rubber Co., Mechanical Goods Division in Wabash, Ind.

PAUL G. HOFFMAN, president of Studebaker Corp. in South Bend, Ind., was recently decorated by the Government of China for his services on the board of directors of United Service to China. Nine other members of the board were also decorated.

WILLIAM J. MILLER is a special agent with the Great West Life Assurance Co. of Winnipeg, Canada. His office is in Seattle, Wash. Prior to this, he was automotive chief with the War Assets Administration in Seattle. In 1946, Miller was chairman of the SAE Technical Committee.

Now owner of the Hensley Truck Body & Equipment Co. in Richmond, Va., **RALPH E. HENSLEY** had served as regional transportation engineer with the White Motor Co. in New York City. In 1947, Hensley was advertising manager of the SAE Metropolitan Section "Accelerator."

DR. K. G. MACKENZIE, assistant to the vice-president of The Texas Co., was active in organizing an Open Forum on Tractor Fuels, Jan. 9 at the Edgewater Beach Hotel, Chicago. It was sponsored by Technical Committee I of the ASTM D-2 Committee. Officers include EARL M. HUGHES, a farmer near Woodstock, Ill., chairman; **ELMER McCORMICK,** John Deere Tractor Co., vice-chairman, and R. E. VOGEL, Standard Oil Co. (Ind.), secretary. The committee was organized to deal with specifications, methods of test, and nomenclature for distillate fuels for tractors, and is composed of representatives from farm organizations, tractor companies, and petroleum refineries. Among the speakers will be **RAYMON BOWERS,** assistant chief engineer of International Harvester Co.

PHILIP R. McGINNIS, who had been a mechanical engineer with the American-LaFrance-Foamite Corp. in Elmira, N. Y., has become a staff member, Division of Industrial Cooperation at Massachusetts Institute of Technology.

Before becoming district manager of the Jacksonville Region for the Kaiser-Frazer Sales Corp., Willow Run, **CLARENCE L. GILLHAM** was merchandising manager for Hudson Florida Motors, Inc. in Jacksonville, Fla.

GEORGE W. CODRINGTON has been elected to serve two years on the board of directors of the Diesel Engine Manufacturers Association. He is a vice-president of General Motors Corp. and general manager of the Cleveland Diesel Engine Division.

Until recently a production engineer with Curtiss-Wright Corp. in Caldwell, N. J. **ANTHONY W. SOUNES,** has now become manager of the Bealles Service Co. in Pittsburgh, Pa.

At its recent annual meeting in New York City, the Navy Industrial Association elected as its vice-chairman **J. CARLTON WARD, JR.,** president of Fairchild Engine & Airplane Corp.

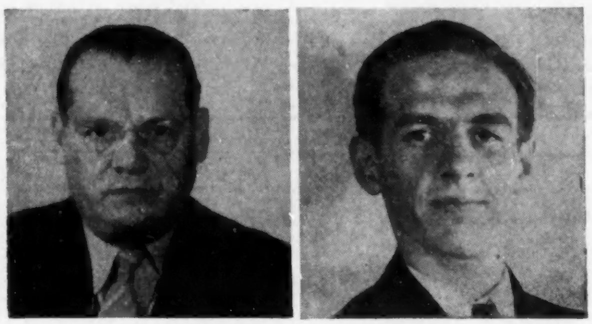
Previously a design engineer with the Four Wheel Drive Auto Co. in Clintonville, Wis., **JAMES E. WARRICK** is now an engineer in the Research Department at Ford Motor Co., Dearborn.

PRESIDENT TRUMAN congratulating **LEWIS A. RODERT,** chief of the Flight Research Branch of the Cleveland Laboratory of NACA, winner of the 1947 Collier Trophy. His work on thermal ice prevention for aircraft won for him the nation's highest aeronautical award. Among previous winners have been these other SAE members: the late DR. ORVILLE WRIGHT, 1913; ELMER A. SPERRY, 1914 and 1916; GROVER LOENING, 1921; GLENN L. MARTIN, 1932; FRANK WALKER CALDWELL, 1933. and ADM. LUIS de FLOREZ, USNR, 1943, (then a Navy Reserve captain)

SAE Fathers and Sons . . . . .

An SAE member since 1926, **CARL T. DOMAN,** left, with his son, **DAVID.** The father is vice-president and chief engineer at Aircooled Motors, Inc., Syracuse, N. Y. David is taking the cooperative course in mechanical engineering at the Rochester Institute of Technology, Rochester, N. Y. and is also an engineering draftsman at Aircooled Motors. The elder Doman's brother is also a member of the SAE. He is **GLIDDEN S. DOMAN,** president and chief engineer of Doman-Frasier Helicopters, Inc. in New York City. Their father, **ALBERT,** who was a member from 1913, passed away in 1934.

E. V. LANSKY, left, is a dealer of war assets surplus machinery and is co-owner of the E.V.E. Mfg. Co. in Chicago. His son, **ZDENEK J.,** is a research engineer at the Stewart-Warner Corp., same city. They both joined the SAE in 1944.



If any SAE reader knows of SAE Father-and-Son combinations, both of whom are members of the Society, your editors would appreciate hearing from you.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated – we don't want to miss any SAE grouping.

JOSEPH W. PARKIN, III, far left, with his father, **J. W. PARKIN, JR.** The father is owner of his own business in Philadelphia and the son is a field service engineer with the company. At the left is the father on a motorcycle which was built by the son's grandfather around 1901. He raced the late **ALBERT CHAMPION** in a five mile match race on this cycle and defeated him. He also drove the cycle to a new world's record for the mile at that time.

Now employed by United Aircraft Corp., Pratt & Whitney Aircraft Engines, in the Production Engineering Department, **JOHN T. TEPLEY** had been a draftsman engineer with Republic Aviation Corp.

FRANK L. COERS is now supervisor of research test engineering for the Cummins Engine Co., Inc., of Columbus, Ind. Prior to this post, he was research field engineer with this company.

Formerly an engineer with Starr, Duff & Smith, Inc., of New York City, **LEWIS R. GWYN, JR.**, has become secretary and treasurer for the Overseas Equipment Corp., same city.

CURTIS L. MOODY has been appointed factory manager of the United States Rubber Company's Detroit plant. He will continue as assistant production manager of the Tire Division.

Now chief mechanical engineer with the Deering Milliken Research Trust in Greenwich, Conn., **JAMES BYRON JONES** had been manager of the Aerophysics Department at the Goodyear Aircraft Corp. in Akron, Ohio.

No longer a development engineer with Jack & Heintz Precision Industries, Inc., Bedford, Ohio, **CLAYTON McKRILL**, has become a designer with the Mobilift Corp. in Portland, Ore.

Having served as design engineer with Jaros, Baum & Bolles, **MAURICE BENTON** recently became a mechanical engineer for Jorgensen & Schreffler in Miami, Fla.

No longer an automotive engineer with the Standard Oil Co. (Ind.), Mason City, Iowa, **WALTER L. MacARTHUR**, has become lubrication engineer with the California Oil Co. in Chicago.

Recently a mechanical engineer with the National Advisory Committee for Aeronautics in Cleveland, **J. DELMONT DURHAM** has accepted a similar position with the Sheffield Steel Corp. in Kansas City, Mo.

MARLBORO KIMMEL DOWNES, formerly with the Civil Aeronautics Administration in Helena, Mont., is now chief of the Program Performance Division of the CAA in Washington, D. C.

FREDERICK C. BRANDT recently became a field engineer with the Southern California Edison Co. in Los Angeles.

Heretofore a salesman for the Moore Equipment Co. in Stockton, Calif., **C. HUBERT SMITHSON** has taken a similar position with the Shaw Equipment Co. in Dallas, Tex.

WALTER E. THILL will head field engineering activities for Federal-Mogul Service in Coldwater, Mich. Before his transfer to the Service Division, he was employed for 10 years in the Federal-Mogul Engineering Department as a design and sales engineer. Thill is a member of the SAE Detroit Section Governing Board, and a frequent SAE author.

ROBERT E. BUSEY was recently appointed assistant chief engineer at Willys-Overland Motors, Inc., Toledo, Ohio. Formerly executive engineer for White Motor Co., he will now serve as direct assistant to **WALTER D. APPEL**, chief engineer, in the coordination of body and chassis engineering for passenger cars, trucks and Jeep models at Willys-Overland.

A. R. LEUKHARDT is the newly appointed assistant sales manager of the Power Brake Division of the Midland Steel Products Co., Cleveland and Detroit. He was recently connected with the Air Brake & Equipment Corp. of Newark, N. J. as manager and treasurer. He had been with Bendix Westinghouse and the preceding Westinghouse Air Brake Co. in various capacities from 1924 to 1946.

ROBERT W. CARR is now a special industrial representative for the Shell Oil Co., Los Angeles. During the war, he was an Army Ordnance petroleum officer with headquarters in Washington, D. C., and at the time of his release was assistant chief of Fuels & Lubricants Branch, Office of the Chief of Ordnance in Detroit. Prior to the war, he was with Esso in New York City.

JOHN K. NORTHROP, president of Northrop Aircraft, Inc., has been elected president of the Institute of the Aeronautical Sciences for 1948. He is the sixteenth president to take office. Other SAE members who were elected to office are: **CLARENCE L. JOHNSON**, chief research engineer of the Lockheed Aircraft Corp. and **R. P. LANSING**, vice-president and group executive of Bendix Aviation Corp., both elected as vice-presidents. The 1948 treasurer is **SHERMAN M. FAIRCHILD** of Sherman Fairchild & Associates.

HERBERT G. FALES, of New York, has been elected an assistant vice-president of the International Nickel Co. of Canada, Ltd., and **T. H. WICKENDEN** has been elected a vice-president of this company's U. S. subsidiary, the International Nickel Co., Inc. Wickenden joined International Nickel in 1922. In 1943 he was made manager of the Development & Research Division, which he continues to head.

W. COYLE COCHRANE has recently been selected as district sales manager of the Pittsburgh Division of Cities Service Oil Co. with headquarters in Pittsburgh, Pa. For the past three years he had been district manager for the Perfect Circle Co.

No longer a designer for the Harley-Davidson Motor Co. in Milwaukee, Wis., **JOHN R. BOND** has become a project engineer with L. G. S. Spring Clutch Corp. in Indianapolis, Ind. He has been a member of the SAE since 1935.

ARNOLD M. LENZ has been appointed executive assistant to the general manager in charge of all manufacturing at the Pontiac Motor Division of General Motors Corp. He started to work for Buick in 1916, joining Chevrolet in 1919, where he remained until appointed to his present position. Lenz was the 1943 SAE vice-president for the Production Activity.

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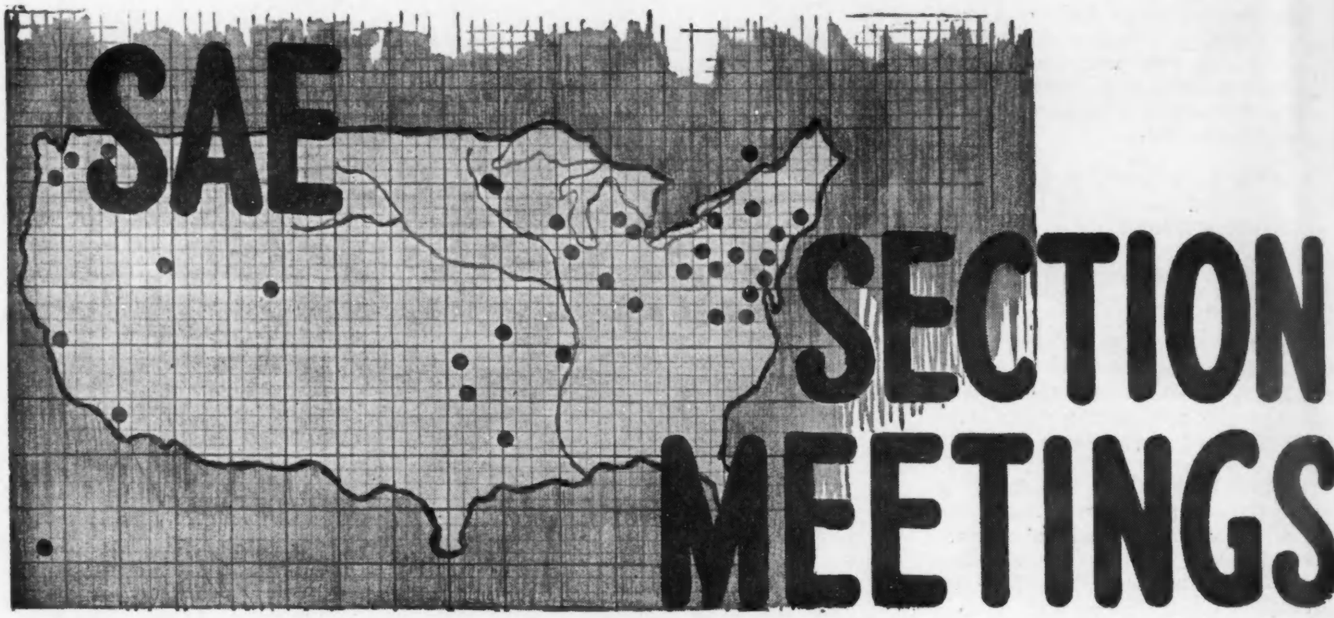

Gasoline from Coal Called Possible Soon

by MURRAY FAHNESTOCK, Field Editor

PITTSBURGH Section, Nov. 25 – "Although the production of synthetic gasoline from coal is an established fact, you won't be able to refuel your car at the pit-mouth tomorrow. But the economic production of gasoline from coal is commercially possible within the next decade," said Dr. H. S. Turner, speaking to an interested assembly of technicians at the Mellon Institute.

Acting as technical chairman, Dr. M. A. Elliott remarked that in the fast-moving automotive industry, yesterday's laboratory curiosity had a habit of developing into today's industrial plant. Automotive engineers, who have developed automotive engines producing millions of horsepower but with insatiable appetites for gas and oil, are rightly concerned as to where "tomorrow's meals" of fuel are to come from.

Turner, who is assistant director in charge of Pittsburgh Consolidation Coal Co.'s Research Center, emphasized the surprising increase in demand for liquid fuels such as oil and gasoline – greater than at any time during the war. Added to the increased cost of finding oil and getting it out of the ground, he said, this has created a need for developing other sources of coal and gasoline.

He pointed out that coal, the largest single source of fuel in this country, provides the answer to this problem . . . provided commercial methods can be developed for converting it into liquid fuels. While coal has been synthesized into oil on the lecture platform for 30 years, it is only recently that development has been extensive enough to indicate that it may be accomplished economically in the next decade.

Discussing possible methods, Turner said that some had been tried successfully in Germany. But these methods are not directly applicable in the United States; modification and improvement will be required before they can be adopted here commercially. And other methods are in process of development here that have advantages over the German means.

Turner sees synthetic oil from coal as a supplement, rather than replacement, for natural petroleum, at least for many years. He said that any near-future, wholesale replacement of natural petroleum with synthetic oil from coal would involve such vast expenditures for capital investment and the literal creation of so many thousands of new miners that it could not be given realistic consideration.

During the discussion that followed, it was emphasized that oil uses are increasing in much greater ratio than new reserves of crude oil are being discovered, and that replacement costs of drilling equipment and of finding oil are increasing sufficiently to drive oil prices upward. Another war would skyrocket demand.

A conversion plant to produce 25,000 bbl per day of liquid products from coal might use 14,000 tons of coal per day. Such a plant might produce 19,500 bbl of gasoline per day, of which about one-third would be 80 octane gasoline, but gasoline of a type highly responsive to still higher octane ratings by additions of lead, for use in Kettering's high compression engines. It could also make 2000 bbl of diesel oil per day. One discusser said that the railways have on order 900 diesel locomotives, as compared with only 17 steam locomotives.

Concerning relative costs, Turner said his rough guess was 5¢ more per gal for gasoline from coal. This extra cost might be reduced by profits derived from coal tars and other by-products. Transportation costs, too, would be relatively low since many mines are located near the large population centers where gasoline and fuel oil are consumed. One big wartime bottleneck was transportation of oil.

Best type of coal to use, Turner said, is that with the highest percentage of hydrogen.

Answering a question about the economics of underground gasification, Turner said it is still too early to evaluate them. But there are certain technical difficulties – among them the problem of producing a gas of uniform composition.

Urges Plane Noise Reduction at Source

by W. A. DAY, Field Editor

WICHITA Section, Dec. 11 – More attention to airplane noise sources, W. E. Burnham suggested at this meeting, would have reduced weight and expense of insulating today's airplanes, and minimized complaints from residential areas and proposals for noise-governing laws.

Burnham, staff engineer from Beech Aircraft Corp., presenting his SAE Aeronautic Meeting paper titled "Reduce Airplane Noise through Basic Design," said that the first real attempt to soundproof an airplane was made in 1932 by insulating the ship itself at the expense of considerable weight and cost. Improvements since then have merely reduced the noise level inside the airplane.

Worst offender is propeller noise, with its main components of rotational note and vortex noise. Proper design would reduce both with no loss of effi-

ciency. Burnham showed charts comparing noise level, efficiency, and cost of various types of propeller for personal planes. Least desirable of those Burnham considered is an 8-blade, constant-speed propeller . . . best, a 2-blade, controllable-pitch propeller of large diameter. Other noise sources, in order of their importance, are exhaust, engine clatter, airborne noises, and ventilating noises.

At a distance of 300 ft, the average exhaust noises are drowned out by propeller roar; if the predominating propeller noises were reduced, the exhaust system would have to be given special attention. Present mufflers are inadequate for aircraft engines with high output.

Burnham believes airplane noises will be eliminated gradually, not through any revolutionary developments.

Shortage Magnifies Value Of "Middle of the Barrel"

by ROBERT T. JACKSON, Field Editor

INDIANA Section, Dec. 11 – The current shortage of petroleum products has spotlighted the "middle of the barrel" – that fraction of crude petroleum which is higher-boiling than gasoline but lighter than lube oils.

D. P. Barnard of Standard Oil Co. (Indiana) used slides to illustrate his paper on "The Contest for the Middle of the Barrel" which touched on and answered several points of concern in the present petroleum products situation. The middle-of-the-barrel cut, he said, will usually have an initial boiling point under 400 F and an end point possibly as high as 760 F. The amount of this cut will average about 37.5% for mixed crude bases. From this fraction come kerosene, high-speed diesel oils, furnace oils, and others, as well as gasoline produced by cracking

From the first oil well until the advent of the automobile, Barnard said, kerosene was the only oil product in demand, and gasoline was discarded. The automobile centered demand on gasoline. It was the cracking process that raised the middle-of-the-barrel portion from by-product to gasoline.

This and other developments brought the possible gasoline yield on crude from about 18% to its present actual total of more than 40%. Over half of the 2,000,000-odd bbl of gasoline produced per day in this country comes from cracking operations for converting a substantial proportion of the middle-of-the-barrel fraction to gasoline. A gasoline demand that is 30% above prewar levels has raised demand for this middle-of-the-barrel source material.

In addition to the increased gasoline demands, the middle-of-the-barrel is called on to supply much greater quantities of its other products – diesel and furnace oils. Thus, Barnard explained, arises the contest.

New large diesel railroad locomotives will consume from 4000 to 8000 bbl of fuel each per year, compared with 1000 bbl used by the smaller switching locomotives. Heater and furnace oils are increasingly used. It is estimated that 4,000,000 domestic oil burners will be in use by 1950. In fact, output of all petroleum products exceeds the highest wartime figure by about 7%, and has not yet caught up with demand.

The present product shortage is not, Barnard emphasized, evidence that we are running out of oil. About 5 1/3 million bbl of crude per day are now available to American refiners. The bottleneck to producing and running more crude is transportation, augmentation of which would require considerable additional scarce structural materials, notably steel.

The demand curve for all petroleum products still has a sharp upward trend . . . it is questionable whether our oil resources can fill future requirements. It is possible that passenger car registrations will increase from the present 28,000,000 to about 43,000,000 in 1970. Gasoline consumption in bbl/vehicle/year can be expected to level off at about 17;

Trucks will probably use about 37 bbl/year in 1970;

Tractors will drain the middle-of-the-barrel for diesel fuel and distillate fuels as well as gasoline.

Every possible source must be investigated, Barnard said, if the industry is to be able to meet peacetime requirements. Immediate and most important source will be the present proved liquid hydrocarbon reserves, now estimated at 24 billion bbl. Consumption has risen, and oil is increasingly harder to find, despite improvements in exploration techniques; cost of wildcat wells has trebled in 10 years, and their production has been cut in half. Thus costs of finding new reserves are about six times what they were 10 years ago, and are still rising.

Other possibilities: Imports, synthetic gasoline (Synthol, perhaps by 1950; hydrogenation of heavy oil residues – 1965; Synthol from coal – 1970). Capital requirements, of course, will climb as substitute sources become more important.

Barnard believes the industry could not handle requirements of another war. Time, money, manpower and materials are adequate for long-range peacetime development of fuels to replace crude oil, but not for sudden augmentation of liquid fuel supplies. Aviation fuel needs in a future war would dwarf those of World War II. Added to lubrication problems, naval requirements, and the needs of mechanized ground armies, these will make staggering totals.

Competent attack of these problems, and careful thinking, Barnard concluded, can solve them – with the assumption of a world at peace. Meanwhile, automobile miles-per-gallon may have

Speaker D. P. Barnard (left) with Section Chairman W. S. Powell at Indiana Section's Dec. 11 meeting

to be stretched by more attention to efficiency, less concentration on larger cars, better acceleration, and higher top speeds.

Section Oldsters Summon Memories of Early Autos

by JOHN D. WAUGH, Field Editor

BALTIMORE Section, Dec. 11 – This meeting was strictly for oldtimers; members forgot about knee action for a few hours and wallowed in nostalgia.

The youngsters (under 50) might listen appreciatively, but they had little to offer. Anything after 1915 was strictly newfangled.

Armed with yellowing photographs and ankle-length dust coats, these auto pioneers swapped yarns about the power sedans of their youth (12 hp – 8 mph) equipped with the latest accessories (genuine windshields and twin carbide lamps).

Each slide flashed across the screen drew a chorus of comments.

"Say, I remember her," chirped a white-haired oldster. "That's the Apperson Jackrabbit, 'No sand too deep, no hill too steep.' "

"Yes, and that's a 1904 tag she's wearing," chimed in another.

"1904, my eye. They didn't put out tags till 1905."

"What d'ya mean?"

Disagreements sometimes marred the reveries: Was the single-cylinder Cadillac the first car with side crank? Did the first Olds have a 48-in. wheel? The authorities differed.

There were slides of 1911 Sears Roebucks, 1909 International Harvesters, Lafayettes, Haynes, Franklins, Peerlesses, and scores of others. Between 1905 and 1920, the experts explained, there were more than 1500 makes on the market.

George Hull, Section placement chairman, presented the featured guest of the evening, C. Raymond Levis, Annapolis real estate man who brought a host of old auto slides and pictures. Levis, who collects old cars, said that his is by no means an unusual hobby. There are 2000 enthusiasts in the country vying for 1000 collectors' items, he said.

As an experiment, Levis gassed up his 1903 Oldsmobile last summer and drove her to Atlantic City. The trip went well enough . . . as far as the car was concerned.

"People kept making comments," he complained. "Other drivers – and station attendants. Some pretty rude."

The boys scoffed at the automotive "new look" which puts the engine in the back of the car.

"That's about as new as my grandmother's bustle," commented one eyebrow raiser. "Remember the 1902 Olds? Had the engine sitting right on the rear axle. Spiral springs and a brass radiator, too."

In a sense, the owners of the pre-fluid drive specimens are a privileged class. Under a Maryland law, Levis explained, owners of cars over 25 years old can buy tags for $1 a year.

He added, however, before a few youngsters could raise their hopes, that the car has to be used solely for exhibition purposes.

FAMME

. . . of San Diego

Joseph H. Famme has spent almost half his 36 years in the aircraft industry, and has been with Consolidated Vultee Aircraft Corp. for 12 years. He was project engineer on thousands of war-famed B-24 Liberators, and now is working on Convair's jet-propelled XB-46, one of the world's fastest bombers.

Famme spent two years doing mechanical work in the wing group for Glenn L. Martin Co., before he went to Johns Hopkins University in 1931 for two years. He returned to Martin as an engineer, and helped design the wing of the China Clipper 4-engine flying boat, and worked on the B-10 twin-engine bomber. In 1935 he joined Fairchild Engine & Airplane Corp., and six months later went to Sikorsky Aircraft Co., for six months. At Fairchild, he helped engineer the amphibian used by the noted explorer Richard Archbold on his aerial expeditions to New Guinea. At Sikorsky, he worked on a number of different airplane projects and helped construct a mock-up of the B-19, later built by Douglas Aircraft Co., Inc.

He was made B-24 project engineer at Convair in 1943, when the 4-engine bombers were being produced at the rate of 12 a day on the world's first mechanized, chain-gear assembly line. He was also a member of the aircraft industry's B-24 engineering committee, charged with coordinating production at the five plants building these planes. After the technical assignment to General Doolittle's Eighth Air Force, checking on overall combat operation of the B-24, he returned to San Diego to become chief design engineer, then project engineer on the 4-jet XB-46.

– by Rex Taylor, Field Editor

RICHARDSON

. . . of Oregon

Earl B. Richardson has seen at close hand the transition from streetcars to rubber-tired, trackless trolleys in his 28 years with the Portland Traction Co. He joined the company after attending Benson Technical School to study electricity and radio, putting in a hitch in the Army in World War I, and a short sojourn in the shipyards.

At Portland, he has been trolley repairman, pitman helper, electric repairman, night foreman, traveling car inspector, chief car inspector, chief inspector, and is now superintendent of equipment.

In spite of the headaches of ironing out bugs in ever-improving equipment, Earl remains jovial and rotund, and during Friday noon luncheons and monthly meetings he rules the chair with a heavy gavel and a voluminous vocabulary.

His lighter moments are confined largely to social activities, and he has been known to bend his elbow with the best on occasion. His hobby is home movies; his present principal project, learning to use his first pair of bifocals, although at the present writing we have had no accurate progress report.

—by Tom E. Allen, Field Editor

Section Chairmen Joseph H. Famme (left) of San Diego, and Earl B. Richardson of Oregon

Although automobiles stole the spotlight, there were a few slides of early airplanes presented by Section Chairman Herman Hollerith. One, a forerunner of the troop-carrying transport, toted an armored, manned motorcycle in World War I.

Hollerith recalled when steam-powered automobiles ran neck-and-neck with electric cars. A man named Stanley was the hero of the hour.

"I remember riding with Stanley back in 1917," he mused. "He'd just brought out a steam model with a condenser. She was a dandy."

Several others echoed his partiality for steam, predicting it might yet replace gasoline as the popular fuel.

Radar Limits Indicate Much-Needed Refinements

by A. M. WATSON, Field Editor

SOUTHERN NEW ENGLAND Section, Nov. 5 – Secrecy produced many false notions during the war about what radar can accomplish, so that its true capabilities must be carefully analyzed to properly evaluate its present status. Actually, members at this meeting at Yale University were told, it is in a very early state of development. It presents no actual picture, and has to be used by a trained eye since anything except air is shown on the screen.

Guest speaker was L. H. Lynn, of General Electric Co., who described radar as a practical use of a long-known phenomenon, developed under highly demanding wartime conditions. Its first application was in 1943, in assisting the Great Lakes ore boats to pass safely from Duluth to Ohio through many rivers and locks, sometimes under completely fogbound conditions.

The first radar units used some 30 gadgets and were far too unwieldy. Since radar units are to be used by operating crews already involved in many other details, control must be extremely simple, and the unit must be easy to service.

Principle involved is similar to that of a light source, reflected from a parabolic surface, projecting parallel rays to a distant target. Such an arrangement in an antenna is used to project a beam of high frequency radio waves against a distant target, and the waves are then picked up by reflection in the same apparatus. Time necessary for the reflection to return is measured in micro-seconds on the basis of a known oscillator beat, and the interval is shown on an oscilloscope screen. With such small fractions (one-millionth) of a second involved, equipment of course is extremely delicate, and also, of necessity, highly developed for accuracy. Present equipment can be used up to a range of 100 miles, but more normally it is used in the 30-40 bracket.

Commonest application is in the PPI (Plan Position Indicator), a special type of oscilloscope pattern in which the reflection time interval that was formerly shown on the oscilloscope screen in the manner of a single line or curve, is revolved about the center of the screen at a rapid rate to provide a plan view of the area into which the beam is projected.

Use of the equipment at extremely close ranges is not practical, as present equipment designs do not allow accurate measurement of shorter time intervals than 1/100 microsec. Present equipment, too, is still "bleary-eyed," more difficult to focus than the eye. It might be compared to a far-sighted and wide-eyed person who is able to detect only gross outlines of distant objects, and unable to pick up details or nearby objects.

Thus, radar is yet a long way from possible use in, for example, trucks. More logical application at the present time, beyond use in aircraft and marine work, would be in railroading, where the presence of "an object" ahead of the train is "announced."

Expense of developing such equipment is quite high. It is clear, therefore, Lynn pointed out, that the war was a major reason for its rapid de-

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Gift to Canadian Section Honors First Chairman

by WARREN HASTINGS, Field Editor

CANADIAN Section, Dec. 17 – Canadian Section's first chairman, Robert H. Combs, was honored, as he traditionally has been since his passing, at the December meeting.

In the photograph below, Section chairman Ed F. Armstrong (right) is seen receiving an album presented in honor of "The Father of the Canadian Section" from Col. Alex McArthur, second chairman of the Section and a past national vice-president for Transportation & Maintenance.

The volume is bound in special hand-tooled leather, with the Society's crest and gold lettering on SAE blue. It is a register subdivided to carry the names of the principal officers of the Section since its inauguration, as well as the names of past, present and future members of the Governing Board and members at large. Col. R. S. McLaughlin, dean of Canadian Section members of the Society (M '09) is being requested to initiate the autographing of this fine permanent record of the Section's membership, a splendidly appropriate milestone of the Section's entry into its majority year.

Hosts at this memorial meeting were Prest-O-Lite Battery Co., Ltd., and Electric Auto-Lite Co., Ltd., the companies with which Combs was associated.

The address of the guest of honor speaker, J. Lance Rumble, entitled "Rambling with Rumble," was of the order that has gained him international fame as a grass-roots philosopher and humorist. A large proportion of the array of characters about whom he reminisces so amusingly lived in the hamlet of his birth, Hillsdale, Ontario, and its environs. The number of Lance's friends and acquaintances is myriad. Years ago he won General Motors of Canada's accolade as the "world's champion truck salesman." Among much else he served with distinction during the war years as the Canadian Government's liaison officer in the construction of the Alaska Highway.

Adam F. Smith, chairman of the Section's Publicity Committee, conducted the annual turkey draw, which grossed over $200 for the Christmas fund of the Sick Children's Hospital.

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some optimism was voiced for American light cars once car supply and demand strike a happier balance.

Practical Soft Tires

Passing from the job ahead to one already completed, passenger car sessions featured reports on newly developed softer tires that boost both safety and car performance. One tire and two car engineers dispelled any doubt as to lack of lateral stability and steering control with these soft tires. Better ride and lower costs also are in store for owners of 1948 cars, many of which will ride on these tires.

The extra low pressure tires are 8 to 12% larger in section, carry 12½ to 25% more air by volume at a 2½ to 8% increase in weight, and are inflated to only 24 instead of 28 psi. Getting proper inflation in service is the big problem. Gas station attendants inflating tires to 30 and 35 psi will nullify soft tire advantages, and might in fact make them worse than conventional tires. Industry recognizes both the huge educational job ahead on proper air pressure and the need for more accurate air gages in service stations.

Claim of greater safety stems from the more positive steering found in tests on these tires. On proper wide rims these tires increase lateral stability or cornering power 5 to 8%. The tire wanders less so that little steering correction is needed.

Greater tire enveloping power makes the car hug the road better. The tire bounces less over road irregularities and obstacles, reducing loss in lateral traction. It gives more positive steering without bounce or chatter at high speeds and on rough turns.

But it does require ¾ to 1¼ lb more steering effort than with current tires, although it's not noticeable without precise comparison. One car engineer didn't agree, reporting wheel fight on several of his company's car models.

Large part of the ride improvement comes from the tire's lateral shock-absorbing ability, which the suspension doesn't have. It also cushions the car from larger road bumps and cavities. Irksome rattling diminishes noticeably. The softer tire also promotes ride comfort by running 15 F cooler in high-speed driving, so that pressure build-up is 1 to 2 lb less.

With about the same tread depth of a 6.00 x 16 tire, the new 6.70 x 15 lasted 15% longer. And because of greater enveloping power, several felt, the new tire's carcass will be less damaged. Others discounted extensive life claims in the face of little substantiating service experience.

Greater cushioning stands to benefit the car body and its many appurtenances from life and service standpoints. Installed on older cars, softer tires eliminate most rattles and vibrations. What happens with less than a complete set of new tires on an old car is open to conjecture. It depends entirely on make of car and kind of driving, ventured the specialists. Most agree that new tires on narrower rims reduce cornering power. So if you're putting on only two new softer tires on your old car, put them on the front, since loss of cornering power on front wheels won't bring instability as it might on the rear.

Prospective users can also expect a slight fuel saving in cars riding on softer tires, advised one speaker. (Other tire researchers reported no change or worse fuel economy.) Reduced power requirements come from two sources – lower rolling resistance and slightly reduced engine speed. Road tests place rolling resistance reduction at 4 to 6%. A new 7.60 x 15 low pressure tire turns 731 revolutions per mile to 754 revolutions for a conventional 6.50 x 15 size. When coasting in neutral, the soft tire will roll slightly farther.

Stylists find the softer tire answering some of their prayers. It gives the car that "new look" because of larger tire section and smaller wheel. The car seems lower and takes on an appearance of stability.

Integrating Production and Engineering

Car engineers also heard how teamplay between engineering and manufacturing can be strengthened. A Buick engineer reported how Production Engineering in his company acts as liaison between Engineering Design and the Master Mechanic, Production, Inspection, and Service Departments. It's the link that integrates functions of all these activities.

If the factory runs into trouble executing designs laid out by Engineering, the production engineer looks into it. He investigates and reports back to Engineering any discrepancies or changes requested. When alternate designs come up in a new program, Production Engineering prepares cost comparisons with help from the Process, Standards, and Cost groups.

Today the Purchasing Department is often faced with critical shortages which can be overcome by substitutions. Production Engineering investigates all proposed substitutions and contacts the design engineer for final okay.

Also under Buick Production Engineering's wing, said the speaker, are all resident engineers at assembly plants who handle engineering information and cooperate with operating departments at their facility. They keep the plant apprised of latest home practices and make periodic 100% inspections to maintain product quality.

The Service Department relies on Production Engineering for technical car-servicing advice. Production Engineering also devises special ser-

vicing, tools, investigates and makes recommendations on unusual service problems. The liaison group often examines materials returned from the field, said its chief, to determine responsibility or need for design changes.

These and other functions performed by Production Engineering lighten materially the load on the design engineer and give him more time for product design. It's the prime mover that keeps Buick departments moving without breakdowns.

Fleet Costs Cut by Fact-Finding Methods Outlined at Sessions on T&M, T&B

Based on discussions and two papers presented at two Transportation & Maintenance sessions, under chairmanship of **F. K. Glynn** and **W. A. Taussig**; two papers presented at two Truck and Bus sessions, under chairmanship of **B. F. Jones** and **S. A. Jeffries** . . . "How to Determine When a Motor Vehicle Should be Replaced," by **Joel Dean**, Columbia University; "Factors that Determine the Proper Intervals between Preventive Maintenance Procedures," **W. J. Cumming**, White Motor Co.; "An Evaluation of Factors Used to Compute Truck Performance," **C. C. Saal**, Division of Highway Transport, Public Roads Administration "Over-all Considerations in Fifth-Wheel Mounting on Tractor Semi-Trailers," **M. C. Horine**, Mack Mfg. Corp. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

WHAT fleet men need to know about their operations, how they can get the needed information, and effective ways to use it were brought into sharp focus in varied presentations at transportation and truck and bus sessions.

The "know-your-operation" theme was applied to buying new vehicles, fitting vehicles to the job, and keeping them economically maintained.

"Is it cheaper to keep operating the old rig or will I cut expenses by buying a new one?" This much-debated question in transportation circles came in for major consideration along a fresh line of attack. An economist injected a new line of thinking when he said the operator must know more than only fleet facts to get the right answer. He must also know how his company invests its funds if his request for new equipment is to get management's okay. Here's why: the new truck or bus investment must earn at least as much, if not more, than other competing company investments to be justified.

That's the real replacement criterion from a cold business standpoint, it was brought out. But it is only part of the story. The complete yardstick includes old-vehicle operating costs and disposal value balanced against comparative future costs of the new one.

Nothing short of all such factors, properly weighed in evaluation of the old truck versus the new, will reveal most economical retirement age. This method's proponents debunked use of rigid formulas as criteria to replacement frequency. Retirement after so many miles, when the truck is fully depreciated, when the truck is worn beyond repair, and other such rules of thumb ignore significant facts in a true cost comparison. All are arbitrary methods based on invalid assumptions, argued the speaker.

Knowing the facts of life was said to apply as well to selecting a new truck. Operating and maintenance costs remain reasonable only if the vehicle is the right one for the job. What to know for this determination resolved itself into what you pay for when you buy a vehicle.

General agreement was reached that the performance characteristics of the chassis-body-engine combination should be considered. Rolling and air resistance, chassis frictional resistance, altitude power loss, and stored energy of rotating parts are among the chief items of performance determinations, most felt.

This motion was seconded by a leading fleet operator who admitted that he, as well as others, brag about how scientific they are; but most fleet operations stumble along on by-guess-and-by-gosh decisions. He hailed this preventive maintenance technique as a much-needed tool for telling the operator why he's doing what he's doing.

How to Find the Facts

New, practical ways to get the needed data on buying, selecting, and maintaining were revealed throughout these sessions.

Method of getting the answer in old-versus-new truck investigations in the economic approach comes easy if the operator asks himself, "What does it cost me now and what will it cost me later?"

Devoid of the economics aura, combined old truck cost includes: (1) loss in resale value by keeping it another year; (2) maintenance cost increase with time; (3) rise in operating costs; and (4) estimate of losses from decreasing reliability due to breakdowns and idle time for repairs. Forecasting such relevent new vehicle costs and aver-

aging them over a long-range period establishes the remaining analysis instrument.

Main difference between these two sets of figures, said the economist, is that the new truck is a long-time commitment incurring costs throughout its life; problem with the old truck is whether to retire it this year, the next, or the one after.

Engineers questioned validity of some of the estimates needed for comparison. Some felt good guesses and future cost estimates might invalidate the decision. From other fleet men came assurance that such "guesstimates" can be made easily. Complete neglect of such factors was said to produce greater error than educated guesses based on past experience. For this reason, a healthy background in specifics of the operation brings sounder assumptions.

Another fleet owner stressed import of revenue consideration as well as cost. He showed where costs of introducing a new bus boosted expenses slightly, but upped the take by 50%.

No such rational procedures prevail in methodizing performance characteristics to find the right vehicle, it appears. Formulas currently recommended were vigorously debated. Lack of experience and sound experimental data accounts for much of the controversy. Tests and full-scale wind tunnel research, not unlike aircraft work, were suggested.

Differences over rolling resistance were cited as a case in point. One source proposes a rolling resistance factor of 10 lb per 1000 lb for smooth concrete, another 12.5 lb, and a third 15 lb. Data developed by some investigators refute the belief that rolling resistance does not vary with speed. Other work mentioned seems to upset conventional thinking, showing rolling resistance to decrease rather than increase with load.

Cause as well as effect of rolling resistance came in for some theorizing. One engineer believed rolling resistance to be proportional to tire resiliency. His tests showed tires can make a difference of as high as 50% in rolling resistance. For example, 100% synthetic tires induce a 5% greater loss than natural rubber ones because of their poorer resiliency.

Operators were told that for air resistance calculations, the standard formula in terms of speed and projected frontal area would do the trick . . . if only prescribed values for the constant didn't vary all over the lot. Manufacturers' recommendations for this value range from 0.0020 up to 0.0050, with no two alike.

No relationship yet shows effect of altitude on gasoline engine power output. But a 3% power loss for each 1000 ft of altitude above sea level was agreed to be valid for practical purposes.

First step in establishing a base for sound pre-

MEETINGS COMMITTEE AT WORK

A few of the Meetings Committee members snapped during the 1948 Annual Meeting. Upper left, George A. Delaney, chairman. Upper right, left to right, W. W. Lowther, M. C. Horine, Joseph Geschelin, John C. Squiers, R. E. Antheil, and Robert Temple. Lower left, left to right, E. C. Guion, A. O. Willey, and 1948 SAE President R. J. S. Pigott. Lower right, left to right, H. W. Luetkemeyer, A. H. Fox, J. E. Taylor, and Floyd F. Kishline

ventive maintenance is to accumulate life expectancy data on vehicle parts in miles. Find the trouble each unit meets up with and when. One maintenance engineer found parts and assemblies fall into well-defined groups. Factors influencing parts life are type of operation, speeds, road conditions, load size, and length of daily hauls.

Example of two vehicles of equal capacity working under different conditions illustrates the point. If one of these two trucks hauls normal loads over good, level roads at normal speeds, it certainly demands less maintenance attention and lasts longer than the other operating continuously overloaded, over poor roads in hilly country at high speeds. The operator must set up a different schedule for each to keep his maintenance costs low.

This speaker showed how he segregated various bus parts into groups with mileage life data gained in the 10-year operation of a New York City fleet. Accessories and parts for this fleet fell into one of five groups. Degree of group breakdown, however, varies with the operation and the vehicle.

Making Facts Pay Off

How to use data effectively after you get them was stressed for every phase of the fleet man's operation.

Putting vehicle replacement cost data to work involves no more than simple arithmetic. Find the difference between old and new vehicle costs. If the new truck yields a profit on par with other company investments, you have a strong case for buying a new one and scrapping the old.

Finding the right vehicle for the job by mathematical methods is more complex, but less unreliable than widely varying performance formulas seem to indicate. The sounder formulas disclosed at the meeting were said to yield surprisingly good results. At least such calculated performance figures comprise a better-than-nothing index to what vehicle best fits the operation.

How to best use data for the maintenance program was shown by further delving into the program set up for the New York City bus fleet. Foundation for its preventive maintenance procedures were the following parts and accessories groups by life expectancy in miles:

- Group L – 2000 miles; (Lubrication)
- Group A – 4000 miles;
- Group B – 20,000 miles;
- Group C – 40,000 miles;
- Group D – 50,000 miles.

Preventive maintenance procedures for each group included that of the lesser mileage groups. A printed form spelling out each inspection is checked as each is completed.

Sound advice came out of discussion on applying preventive maintenance procedures. In every step, argued one operator, first instruction should be "check" – then "correct." Don't put water into the battery until you've seen if it needs water. Preventive maintenance instructions really tell the mechanic: We only think the part may require adjustment or servicing at this mileage. It may not. So look first.

Fleet managers considered preventive maintenance schedules theoretically desirable, but not always practically possible. They said if it comes to choice between holding the truck over for a periodic inspection falling due and dispatching it on a profitable haul, income-producing job takes priority.

Kingpin Offset – How Much?

Both vehicle design engineers and operators found a clear exposition of effects of kingpin offset for tractor semi-trailers equally as stimulating as the truck buying, selecting, and maintaining presentations.

Speaker at this session showed selection of best kingpin offset to be a less than simple problem since both maximum and minimum offset both produce good and bad results. Pros and cons for each show up in the light of their effect on load distribution, steering, braking, ride qualities, maneuverability, traction, and safety. Maximum offset scored higher in most comparisons.

Maximum offset holds advantage in load distribution. It makes for most desirable load distribution on both front and rear tractor axles.

Something can be said for both maximum and minimum kingpin offset as regards steering. Placing the kingpin directly over rear axle – zero offset – reduces steering effort; but reducing weight on front tires increases skidding tendency of front wheels, particularly on slippery footing. Moving the kingpin forward increases front-axle loading and resistance to skidding, as well as steering-wheel turning effort.

No doubt was left as to the lesser of the two evils when one operator told of two serious accidents in the east; both tractor semi's involved had zero offset. Both collisions happened while going up an icy hill.

Reasonable amount of kingpin offset was said to promote braking effectiveness and safety. It keeps load distribution most nearly constant, best meeting fixed braking force distribution in today's vehicles. Ray of sunshine to brake conscious truck engineers was word that it's possible to vary braking effort between any two sets of brakes. A vehicle design consultant claimed feasible a simple proportioning device sensitive to immediate road speed, immediate deceleration rate, violence of brake application, grade, or any combination of these factors.

Extreme offset enhances riding quality, although it can't make a Rolls Royce of a tractor. It does this by distributing part of fifth wheel load to the front axle, reducing rear axle loading. Maximum offset scored another round on maneuverability.

Appreciable offset helps the driver in hard-to-make back-up maneuvers by augmenting sideway movement.

Queries as to specific values of maximum offset recommended brought an answer of about 12 in. Operators were told not to leave offset setting to driver. He usually has a pocketful of "lunch-room" engineering reasons for maintaining zero offset.

One fleet man operating a fleet of tractor semi's on 24-in. offset for several years asked what troubles he should look for that he perhaps doesn't know about. None, he was told, if his throat clearance is adequate. In fact he was congratulated for his courage in using a 24-in. kingpin offset.

AIR TRANSPORT Sessions Spotlight Reversing Propellers

Based on discussions and four papers presented at two Air Transport sessions under chairmanship of **O. P. Echols** and **W. W. Davies** . . . "Direct Flying Costs and Cruise Control," by **S. T. B. Cripps,** British Embassy; "Brazil and Air Transport," by **Ralph N. DuBois,** Aeronautics Institute of Technology of Brazil; . . . Symposium on Reversing Propellers: "The Reversing Hydromatic and Its Control," by **C. F. Baker,** Hamilton Standard Propellers, Division of United Aircraft Corp.; and "Practical Aspects of Reverse Pitch Propellers in Airline Operation," by **M. G. Beard,** American Airlines, Inc. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

At their sessions, air transport engineers explained to manufacturers what the airlines want – what the big American airlines want in reversing propellers, and what type of plane the Brazilian lines want. And airline cost analysts were urged, when figuring what the airline can get in revenue out of a proposed transport, to consider the plane in reference to the route on which it is to be used.

In reversing propellers, the airlines are looking primarily for greater dependability. They want the reversing action to be available immediately after landing . . . manual override to supplement automatic control of reversing . . . compensated idling controls . . . a harder surface on propeller blades to resist abrasion.

What the airlines expect in performance and revenue with a particular plane may not be what they get, if their expectations are based on an analysis which does not take into consideration payload available and wind conditions, as well as direct flying cost and total costs on the route where the plane is to be used. Furthermore, the airline may not get the revenue expected out of the chosen plane, if flight personnel don't understand the cost situation. For them, the various flight plans for the route should be evaluated in the unit flight personnel understand best – dollars.

The Brazilian airlines want a plane intermediate between the high-speed, high-capacity transports and the light personal planes that this country is concentrating on. Brazil is a highly air-minded country, and if the right type of plane is available, air transport may play the same role in the development of that country that the railroads played in the development of this country.

Although the airlines are not completely satisfied with reversible-pitch propellers for landing braking, they already rate it as a real contribution to aviation. A year of operational experience has indicated what changes are needed, and some of those they asked for at the symposium on reversing propellers are even now being made.

The request for manual override on the automatic reversing control stems from instances where the automatic control failed to function. The override must be located where it cannot be inadvertently operated. One way of doing this is to enlarge the slot through which the reversing flag passes – the flag which warns that propellers are in reverse position. Then the pilot can reach in and pull up the flag to actuate reversing.

One trouble the airlines want corrected is that the engines tend to die after the propellers have been reversed – this isn't dangerous, but it embarrasses a pilot to find himself out in the middle of the runway with four dead engines and a load of passengers. Explanation for the trouble is that in going from normal positive position to reverse, the propellers lose speed down to zero thrust, then gain it again. In the low-speed range just after the blades have reversed, airflow is very low, but the idle jet in the carburetor doesn't cut down on fuel. The engine dies of an over-rich mixture. The effect is especially noticeable at high-altitude airports like those at El Paso and Mexico City where air density is low.

Reversed propellers tend to suck up all the loose material on the landing strip. Blades are often seriously abraded. The surfaces must be very hard in order to stand up in service. A wind tunnel expert offered the advice that vinyl coating protects

wind tunnel blades well – it might protect propeller blades, too.

The airlines based their requests on service experience with the electric reversing propeller. Soon to be available is a hydromatic reversing propeller. Its designer explained that operation of the reversing mechanism of the hydromatic is directly analogous to the feathering operation except that reversing takes place at the other end of the blade angle range. In the control system, reversing corresponds to unfeathering, and unreversing corresponds to feathering.

Noted in a paper on cost analysis of transports was a trend toward analyzing planes on the actual route on which an airline intends to use them, instead of in general terms. This trend will improve the accuracy of performance estimation.

The originator of the method, once an airline pilot himself, has extended his analysis, linking direct flying cost to cruise procedure, to evaluate procedures in terms of dollars. This enables operational staff and flying crew to make up their flight plan with full knowledge of the costs incurred.

The head of a Brazilian feeder line was quoted as specifying for his service a plane having a cruising speed of from 90 to 125 mph, three engines, capacity for 4500 lb payload, a 10,000-ft ceiling with two engines, and a range of 750 miles. Cargo capacity should be provided at the expense of passenger comfort, if a choice must be made.

Brazilian airlines are beginning to reach into remote localities not connected by ground transport.

Some idea of the quantity needs can be obtained from statistics presented by a member of the faculty of Brazil's rising Aeronautics Institute of Technology: Scheduled airlines are already flying about 70,000 miles of routes. Nine airlines made 31 trips each way daily between Rio de Janeiro and Sao Paulo. The country has about 600 airports, 120 of which are suitable for operation of DC-3's.

Compositions and Properties of Fuels Highlight Sessions on DIESELS

Based on discussions and eleven papers presented at three sessions on Diesel Engines under chairmanship of **P. H. Schweitzer, A. H. Fox,** and **G. C. Wilson.** . . . Smoke Symposium: "Diesel Engine Exhaust Smoke as Influenced by Fuel Characteristics," by **H. D. Young,** Sinclair Refining Co., "Smoke in High Speed Diesel Engines," by **J. J. Broeze** and **C. Stillebroer,** N. V. Bataafsche, Petroleum Maatschappij; "Influence of Injection Characteristic on Exhaust Smoke," by **Martin Berlyn,** American Bosch Corp., "Rating Diesel Engines on Smoke Curve Basis," by **K. J. Fleck,** Caterpillar Tractor Co., "Technique of Exhaust Smoke Measurement, **F. L. Coers** and **J. P. Jung,** Cummins Engine Co., "The Operator's Viewpoint on Exhaust Smoke," by **A. S. Leonard,** Cummins Engine Co., "U. S. Naval Engineering Experiment Station Investigations on Cylinder Liner Wear," by **W. F. Joachim** and **W. G. Payne,** U. S. Naval Engineering Experiment Station. "Engine Wear Research," by **L. D. Thompson, S. J. Backey** and **E. L. Conn,** Fairbanks, Morse & Co., "Preliminary Report of Studies on the Composition and Physical Properties of Diesel Fuels," by **H. M. Smith,** U. S. Bureau of Mines, "Diesel Combustion Temperatures—The Influence of Fuels of Selected Composition," by **Otto Uyehara** and **P. S. Myers,** University of Wisconsin, and "Combustion Characteristics of Diesel Fuels," by **E. W. Landen,** Caterpillar Tractor Co. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

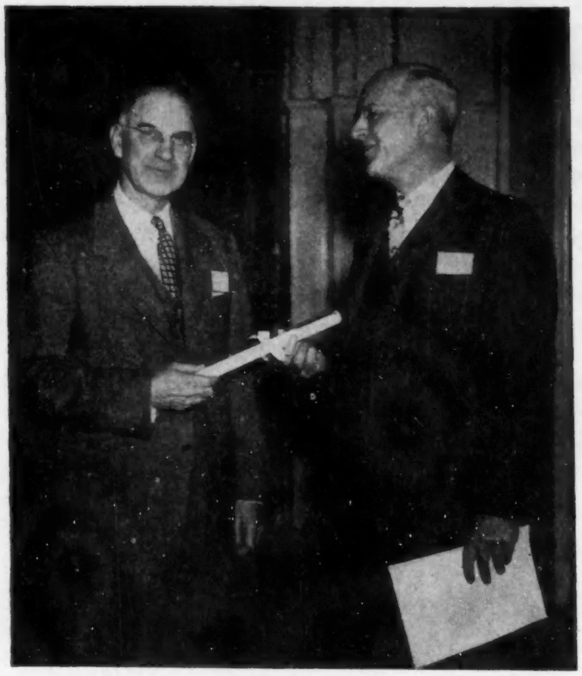
DIESEL combustion process mystery seems near solution in the light of new detection devices for probing clues to more power and longer engine life. Operators, engine and fuel men found hope in new theories on wear and smoke coupled with new ways to eliminate them.

Admittedly babes in the woods as to what really happens in the combustion chamber, diesel engineers feel three new research tools – which disclose secrets locked in fuel molecules, correlate fuel characteristics and engine performance, and expose clues in the exhaust – will trap elusive concepts.

Fuel holds the answer to increasing diesel power, said some engineers. If you try to reduce fuel consumption by raising compression ratio, they say, high price of correcting mechanical troubles would more than offset the gain. Report of a tremendous Bureau of Mine study on diesel fuel chemistry and physical properties added much to their knowledge on what diesel fuel is.

This work was said to be particularly enlightening because diesel fuels are more complicated than gasoline. Complexity arises from both increase in the number of possible isomers as carbon atoms in the molecule increase and – with cracked distillates synthesizing of polymerization or condensation products in cracking.

Introduction of a silica gel adsorption technique, by the Bureau of Mines chemists, for separating various hydrocarbons in diesel fuel is particularly valuable for determination of olefins, found in cracked stocks. This work is timely today with olefin-containing cracked stocks in use to meet the



Past-President James M. Crawford (left) receiving his SAE Life Membership Certificate from C. E. Frudden, SAE President for 1947, during the 1948 Annual Meeting Business Session

huge diesel fuel demand.

Engineers were asked to put this better knowledge of present fuels to work toward improved performance, rather than demand premium diesel fuels. These would destroy the diesel's biggest advantage – low cost fuel.

Other research prying into the fuel's properties in relation to its performance in the engine may provide the help needed, some argued, for the first course of action. In these tests the investigators got extensive flame temperature data with an electro-optical pyrometer. This instrument peers through a quartz glass into the combustion chamber and translates light intensity of the gases into instantaneous temperature readings.

Fiye 40-cetane fuels were selected as a starter. They were: :(1) blend of catalytically cracked stock; (2) a straight-run midcontinent fuel; (3) a 50-50 blend of the first two; (4) a blend of normal heptane and iso-octane, and (5) a blend of cetane and alpha methyl naphthalene. Preliminary results reported show all fuels, except the cetane-alpha mixture, give lower combustion temperatures at earlier points of injection. And earlier injection gave a higher total rate of pressure change.

Validity of the technique was questioned since results didn't check with high-speed photographic studies of diesel combustion. The university researchers advised that the pyrometer reading was not an arithmetic average of radiation but, because of exponential relationships, was something close to the hottest temperature.

Another method of explaining what happens to fuel when it burns in the chamber is a newly-perfected gas analysis technique. The researcher, much like the experienced hunter, can learn a lot about his prey by the tracks left behind. Here exhaust products of a precombustion-chamber type engine were collected by a large condensing system and cooled down to —10 and 0 F.

This is a real shortcut for combustion investigations, many opined, because it helps determine cumulative values of small fuel fractions that normally elude single combustion cycle investigators.

Initial work on exhaust analysis set up several starting points for further work. Amount of liquids and solids exhausted from a diesel, reported this speaker, depends on the engine and operating conditions. At low loads carbon exhausted is slight and increases as the smoke point is reached. Exhausted liquids decrease with increase in load.

The fuel-engine combustion studies announced whetted technical appetites for more complete, more basic answers to practical questions.

Out of a confusion of factors accused responsible for engine wear came general agreement that sulfur is its public enemy No. 1. But the "how" of sulfur-induced wear started conflicting theories flying all over again. Most recent explanation rejects the commonly-accepted belief that wear results from corrosion by sulfuric acid, formed by combustion of sulfur in fuels. According to three engineers, sulfur in fuel combines with hydrocarbon molecules during combustion and forms a black abrasive product. They described it as similar to synthetic rubber hardened by addition of sulfur during vulcanizing. These abrasion deposits, said proponents of this theory, cause most of the wear.

In tests this substance formed in the center of the combustion chamber atop the piston. Regardless of the fuel's sulfur content, the abrasive deposits have a 1 to 3% sulfur content.

Still others felt this work over-emphasized the role of abrasion in wear. Destruction of the oil's lubricating qualities, they debated, merits equal consideration. In one case, for example, change of lube oil temperature from 200F to 240F increased wear from 10 to 13 microinches per hr.

Engineers of the U. S. Naval Engineering Experiment Station reported a newly-discovered kind of wear failure, conceivably responsible for cylinder replacement. They found this wear to be a general surface disintegration evidenced by separation of very fine particles. It's not caused by machining or too-fast run in, as first believed, because the fragmented layer also exists on seemingly normal surfaces. The Navy engineers described it as a separation due to oil film shearing action or cavitation under the piston and rings.

What is clearly needed, they feel, is a finishing technique preventing this condition. Therefore, they went to porous chrome plating which showed appreciable reduction in cylinder liner wear. But they experienced considerable variation in wear

with different plated liners. Variations in life as high as 10 to 1 were found in one engine.

Fact that Navy engineers used some of the earliest liners plated explained the widely-varying results to some. They said the chrome plating art has progressed considerably since that time, better plating control and greater uniformity exists today. Now manufacturers blast the cast-iron liner before plating which increases strength, gives plating maximum ductility, hardness, and strength of bond. Porous or open-grained chrome plate, advised one specialist, outlasts smooth chrome by four to one. It gives interrupted surface contact which keeps heat below the welding point.

A metallurgist said iron should not be abandoned because it still hasn't been properly used and is probably cheaper than chrome. Poor wear showing of some gray iron liners, he believed, is due to improper foundry practice and poor choice of iron analysis. Best wearing iron has random flake graphite and a pearlitic structure. Poor design can also speed wear. In one case redesigning to properly cool the rings completely eliminated scuffing.

Some questioned the claim that chrome costs 40% more but betters performance by 400%. They showed the owner would pay twice the liner cost to get a 44% increase in life expectancy. An unplated liner, according to one comparison, can be replaced with a new one for less than the cost of replating the old liner. (Freight charges borne by the owner is the chief reason.)

Need for more development work to improve plating procedures seemed apparent to most engineers in view of the discussions. The Naval Experiment Station outlined its future three-point program as including:

1. Accelerated wear tests and physical and metallurgical investigations of all types of chrome plating to find characteristics responsible for maximum wear resistance.

2. Attempts to reduce maximum wear from 0.0050 in. to 0.0008 in. per 1000 hr. This will increase minimum liner life to 15,000 hr and probable average life to 30,000 hr of operation.

3. The goal of a cylinder lasting as long as the engine without replacement.

Industry engineers deemed this program a vital one in the drive toward longer engine life. If achieved, they said, these objectives will make noteworthy contributions to the art of diesel engine design.

Smoke Symposium

A diversity of points of view was expressed at the smoke symposium. Some thought better fuels would help to solve the problem; others pointed out that special fuels would cost more, and anyway the effect of the fuel on the amount of smoke produced was so small as to be wiped out in actual practice; some looked with favor on legislation regulating diesel-engine smoke, others looked with disfavor on such legislation, pointing out that steam engines and factories emit smoke – and it's part of the price we have to pay for the modern way of obtaining power; some wanted more time devoted to the problem of measuring the amount of smoke produced in particular engines more exactly, others felt that this was not the problem, that the time would be better spent in figuring out how to eliminate smoke entirely.

Whatever their individual opinions may be as to the relative importance of this exhaust smoke problem, it seems to be quite clear that engine and equipment manufacturers, oil refiners, operators, and law enforcement officers are all cooperating in an intensive effort to reduce the nuisance.

Smoke Problems Argued

Effect of fuel properties on the amount of smoke emitted from an engine was argued from many angles. It was pointed out that certain special fuels devised by one investigator to overcome the smoke would inevitably cost more and would provide a distribution problem unless universally used.

It was suggested that some reduction in smoke obtained with the special fuels might, in part at least, be due to a lower power output – and it appeared that, although no power loss had actually been measured, bus operators using them have reported poorer acceleration characteristics, indicating some power loss.

Although cetane number was reported to have some effect on smoke, it was admitted that fuel volatility appears to overshadow this influence.

Both exhaust smoke and odor were said to be influenced appreciably by engine jacket temperature. Maintenance of a high jacket temperature was said to contribute measurably toward reduced exhaust smoke, possibly overshadowing the influence of fuel effect.

As one discusser pointed out, this is entirely logical, for one of the basic requirements of the diesel engine is to conserve the heat of compression and get the compressed air as hot as possible with a given compression ratio. A refrigeration engineer would accomplish this, he thought, by putting about 4 in. of insulation around the cylinder walls and combustion chamber.

What effect fuel will have on the smoke produced by an engine was reported to be dependent on the type of engine used. The precombustion type appears to show characteristics quite different from those of engines with direct injection because of the different way of fuel distribution. With direct injection, the fuel is distributed by a spray, so that evaporation and air movement have to correct the incompleteness of the distribution. In a precombustion engine, the injection system has the function in the distribution process which is performed

by evaporation in the precombustion chamber and by blast from the initial explosion in that chamber. This property of the precombustion chamber was said to reduce the tendency to smoke and have other desirable characteristics.

One engine manufacturer called for a measure of smoke to be included with engine performance data. He felt the smoke curve is actually one engine performance criterion, and that it tells a more profound story than exhaust stack temperatures.

To measure this smoke seems, however, to present many problems. For instance, it was said to be difficult but very important to get a representative sample for all speeds and loads.

Some of these difficulties were discussed at the meeting, such as:

• When samples were taken at various points along the exhaust pipe, it was discovered that the particles collected nearest the engine were very minute, and they increased in size as the distance from the exhaust increased.

• The highest of several smokemeter readings is not always the most nearly correct, as is often assumed, for if water is allowed to condense in the smokemeter, the lowest reading is the best one.

• The flow of gases in the exhaust is characterized by zones of high and low pressure, which may be static or in motion, and the point of sampling becomes critical if some method isn't used to overcome the differences in pressure. One successful method of doing this, which gave a flat smoke density-charging pressure curve, was reported. A 1/8-in. slot was located in the exhaust pipe so as to offer its full width to the direct flow of the exhaust stream, 43 in. from the exhaust manifold flange, and connected to a CRC smokemeter with 72 in. of 3/4-in. OD and 1/16-in. wall copper tubing.

The successful marriage of fuel and air in a cylinder is the joint responsibility of engine design and injection engineers, another speaker said, so that smoke-free operation under all reasonable conditions of service requires the closest collaboration of these two throughout the development of the engine.

He called for the elimination of certain mannerisms of injection that generally give rise to smoke: secondary injections, nozzle dribble, a long, declining tail on the fuel pressure-time diagram, inadequate initial rate of injection, or anything leading to protracted duration of fuel discharge from the nozzle.

Other attributes of injection that were reported to give rise to smoke under at least some conditions include: excessive penetration of spray, insufficient penetration, uneven or improper dispersion, unsuitable droplet size, improper timing of start of injection, improper rate of injection during discharge, and excessive duration of injection.

Construction Machine Standards Featured with Transmissions for TRACTORS

Based on discussions and two papers presented at one Tractor and Farm Machinery session, under chairmanship of **B. G. Van Zee** . . . "Tractor Transmission Gears – Current Industry Practice," by **W. H. Worthington and B. G. Rich**, John Deere Tractor Co., and "Report on Activities of SAE Construction and Industrial Machinery Technical Committee," by **C. G. A. Rosen**, Caterpillar Tractor Co. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

ROUND-UP of current design practices in tractor transmission gears and story of SAE Construction and Industrial Machinery Technical Committee's big standards job kept tractor meeting discussions in high speed.

Tractor manufacturers agree about how to make transmission gears, but designers differ on how to analyze the stresses in them, tractor engineers learned from a survey of 11 different tractor transmission models reported at the meeting.

Most spur gears in the transmissions studied are of alloy steel. Included were SAE 8620, 8640, 8615, and 4620 steels. Majority of transmissions are made from low carbon steel, carburized and hardened. Gas carburizing and direct quench seem to be gaining ground.

Makers of this survey said several transmissions are made from full-hardening steel quenched out of cyanide. One final drive gear is induction hardened and another flame hardened. Perhaps local hardening of teeth is on the way. All gears are induction hardened in one transmission.

Shaving was found to be the predominant final finishing method. In four designs all gears are shaved; in four others all except slow-speed gears are shaved.

The industry's conformity in manufacturing practices doesn't extend to engineering design.

SECTION AFFAIRS

Head table of Sections Committee luncheon at which 18 Sections and Groups were represented. . . . Facing the camera (left to right)are: R. J. Waterbury, 1947 Sections Committee chairman; Hollister Moore, manager, Membership & Sections Division, SAE staff; T. L. Swanson, 1948 Sections Committee chairman; C. E. Frudden, SAE President for 1947, and C. M. Larson, 1948 Placement Committee chairman. Larson presented his program to up listings of job opportunities and set up "personnel consultant" groups in each Section

Variety spices both surface compressive stress and beam stress calculations.

Some compute tooth load using maximum load determined by engine power. Others take a fixed percentage of load – 70 to 75%. A third group uses varying percentages of load, depending on tractor ground speed. Some use a pitch-line velocity factor, others do not. Certain engineers favor a life factor based on estimated life cycle of the gear. In a few cases a correction factor evolved from gear rpm finds its way into calculations.

Beam stress analysis also enjoys divided opinion as represented by "Y" and "Z" factor advocates. The "Y" factor assumes maximum load application along line of action normal to the involute surface at the tooth's tip.

The "Z" factor presupposes that a gear tip mating at its tip doesn't carry all the load since an adjacent tooth making contact carries part of it. Followers of this approach also feel the gear tooth face carries maximum load when the preceding tooth breaks contact. At this time load is applied considerably below the tip. It tends to shorten beam length of tooth. Mounting rigidity not achieved in dynamometer testing may upset the "Z" factor applecart; it's known to have increased gear life to 10 times that predicted.

One engineer decried divergence in gear stress calculations as casting little credit on designers. Untangling the maze of variables is step "one" to uniformity, in his opinion. Method variation little concerned another since spread in answers is narrow, regardless of factor. Desired life was advanced as key to best design practice. Then stresses would vary with intended gear life. Higher stresses would go with shorter-life gears.

Deep general interest in unearthing best design criterion brought demands for further explorations and disclosures in coming SAE tractor meetings.

Cooperative standardization in construction equipment engineering is enjoying industry enthusiasm and real accomplishment in the SAE Construction and Industrial Machinery Technical Committee, reported its sponsor. Within its first year this group readied for final approval the following first-time interchangeability standards:

1. Standardization of drawbars and rear-mounted units on tractors;
2. Recommended simplification of tire and rim sizes and types for construction and industrial machines;
3. Yardage rating of bodies and buckets.

Dimensional standards for tractor drawbars have been prepared for all tractors from 50 to 175 hp. Their approval was received in time for publication in the 1948 SAE Handbook. Next project in this area is rear mountings for 0 to 50 drawbar hp tractors.

On tire size standardization the group has recommended cutting haulage and grader types from 41 and 26 to 35 and 19, respectively. Progress is also being made toward interchangeability of wide-base rims. The Committee sponsor felt current differences in practice will soon be compromised.

Third standards project, yardage rating of bodies, has reached the proposal stage as a standard for struck and heaped capacity ratings for carry-type scrapers, trucks, and wagon bodies. Committee members responsible for this work were commended for their productive efforts on this controversial issue.

The Committee's sponsor expressed his appreciation of the high spirit shown by the results. He

said engineers from Seattle, Long Island, Allentown, Pa., and other far-away areas attended up to six meetings within the past year.

So eager have been the members to give the benefits of standardization to manufacturer and user alike, they've already undertaken two other projects – standardization of hydraulic power controls and electrical equipment.

MATERIALS Experts Explore Greater Economy

Based on discussions and five papers presented at two eessions on Materials, under chairmanship of **R. W. Roush** and **W. M. Phillips** . . . "Present Day Approach to the Choice and Application of Automotive Steels," by **W. E. Jominy,** Chrysler Corp.; "Applications, Materials, and Specifications of Bolts," by **W. C. Stewart,** American Institute of Bolt, Nut and Rivet Manufacturers; "Improved Automotive Finishes as Engineering Materials," by **Maurice Bell** and **W. W. Bauer,** Pittsburgh Plate Glass Co.; and "Control of Materials by a Motorized Laboratory," by **H. A. Tuttle** and **G. A. Nahstoll,** Ford Motor Co. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

SPECIFIC ways to cut vehicle manufacturing costs were suggested at the two Materials Sessions:

• By using hardenability specs in buying alloy steels.

• By developing more codified knowledge about bolts.

• By continuing to improve automobile finishing methods, as well as the painting materials.

• By using mobile metallurgical test equipment to spot check materials during the production process.

Growing out of these specific suggestions came other more general cost-reduction ideas in papers and discussion which focused heavily on production economies.

Hardenability versus Chemical Specs

The economy advantages of using hardenability rather than chemical specs in buying alloy steels, urged by many articulate mill and vehicle metallurgists for several years, are becoming more and more clear as time goes on, discussions at these sessions indicated. It seems equally clear, however, that there still is much to be said on both sides.

Hardenability-spec proponents see greater economy in use of such specs because they give a better chance of getting required strength for parts.

The economies become particularly apparent, they say, in the face of threats of shortage in alloying elements required by the chemical specs, because the hardenability route permits steel mills to get the best alloy-results out of available materials.

Enough experience, proponents brought out, has been had with hardenability buying to demonstrate its value already. Probable further narrowing of hardenability bands, they add, will increase the method's advantages for users as well as producers. Some engineers were found claiming – contrary to earlier opinions – that there isn't much difference in the engineering properties of various alloy steels, anyhow, as long as they are properly heat-treated.

The humble bolt is used in such vast quantities, it was shown, that every little bit of additional knowledge developed about its design, torquing stresses, and load-bearing ability can play a real part in cutting manufacturing costs.

Strongly urged at these sessions was a joint research project involving engineering societies to better compile and codify present knowledge about bolts and to assign new problems for further research.

Improved Car Finishing

Cost and quality improvement in automobile finishes is most likely to be continued by licking remaining problems in use of the well-established lacquer and synthetic enamel finishes, opinion at these sessions indicated. Radically different finishes are not just around the corner, it was agreed. Engineers pointed to 25 years of tremendous progress in raw materials, finishes, and application methods as the pattern for continued cost reduction and quality increase.

Improvement in the raw materials often is responsible for the better application techniques which bring lower costs, it was pointed out. One example cited was: better lacquer quality brought an increase in the solid content at the gun, permitting fewer coats to attain a standard film thickness.

Projecting such possibilities into the future, one speaker suggested for specific solution without cost increases such existing troubles as: (1) lacquers are sometimes force-driven too near the temperature of decomposition of nitro cellulose; (2) lacquer films are sometimes applied at such excessive thickness as to invite thermal cracking; (3) sometimes film thickness is not uniformly controlled to

gain maximum moisture and corrosion resistance.

Cost was a main factor stressed by those who see radically different finishes as unlikely soon. "Economic factors make an early replacement of lacquers and synthetic enamels an improbability," one expert said, although admitting that continued chemical research might reverse his prediction.

Major long-term cost reductions were hinted at, however, by one quoted authority who sees the progress of the last 25 years as only a fraction of what to expect in the next 25 – chiefly, it would seem, through improved chemical engineering processing of coating by the coating producers. "Technically trained men," he was quoted as saying, "are thinking more and more in terms of changing from batch processing to continuous methods of production . . . not only in varnish manufacturing but also in the dispersion of pigments into paint vehicles."

Thousands of manhours have been saved by putting metallurgical test equipment on a truck and moving it about to spot-check materials during production, it was brought out by other authors who had cost-reducing ideas to leave with the materials engineers. Used to augment main laboratories, they said, the truck with its test personnel has been found valuable in making spot checks in the Rouge Ford Plant and in checking scrap alloys.

Equipped with a semi-portable spectroscope, selected chemical spot test kits, carbon-by-color tester, high speed grinder for spark testing, and Brinell, Rockwell, and Scleroscope hardness testers, and a magnetic plating thickness indicator, the truck has done in 768 hr work which would have required 2876 hr in the company's main metallurgical and chemical laboratories.

On the production lines, vehicle frames have been successfully spot checked for hardness without cutting them for samples to be sent to the laboratories. Identification of steel bars and shapes by alloy content, as well as test of semi-finished parts, has made the mobile laboratory an important money saver in car, truck, and bus production, the authors declared.

BODY Engineers Hear of Light Automobile Ideas, Study Structures, Materials

Based on discussions and three papers presented at two Body sessions under chairmanship of **Clarence Kramer** and **J. W. Greig** . . . "How Unit-Trust-Panel Buses Carry Their Loads," by **L. H. Smith**, consulting engineer; "Practical Use of Low-Alloy High-Tensile Steels in Automotive Structures," by **C. L. Altenburger**, Great Lakes Steel Corp.; and "Do Americans Want a Small, Light Car?" by **E. R. Grace**, Grant Advertising, Inc. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions

PUBLIC desire for a utility car at lower-than-present prices, even though somewhat smaller and lighter – indicated by survey results presented at the Body Sessions – is already being reflected in engineering design thinking revealed at these as well as other Meeting sessions.

Even as Body audiences were being told that 60% of the public is interested in a cheaper, even though smaller, car, engineer speakers were debating the role of low-alloy, high-tensile steels, monocoque body constructions, higher engine compressions, engine-fuel matching, and other technical avenues by which public desires might be met. The low-alloy, high-tensile steel possibilities and monocoque body construction – the latter discussed in terms of bus applications – were the angles emphasized particularly at body sessions, following through on the study of public desires revealed by an extensive survey.

Automobile engineers were warned that today's backlog of orders for new cars is in danger of shrinking overnight unless a smaller, lighter car of definitely lower price is produced to fit the pocketbooks of a large part of the American public.

This possibility came to light as the result of a nationwide survey of car drivers made in December by one of the speakers. Of those interviewed, 60% were now interested in such a car. When this figure is compared with the 39% obtained in a similar survey made early in 1947, he declared, it is quite clear that acceptance of the idea of even a smaller car at lower-than-current prices is becoming more widespread.

The survey also indicated that the public is beginning to show more interest in utility than ever before. Of those interviewed, 50.4% said they desire primarily a utility car, whereas 49.6% said they desired first that the smaller car be smartly styled and more luxurious.

The survey was said to have revealed further that lower costs – both initial and operating – rather than a real preference for such a car were

the determining factors. The American motorist still likes a big car, it appears, but the high cost of living is making him count his pennies before he makes a purchase – and that goes for the new car, too.

It appears he has definite ideas about how much he is willing to pay – or rather can afford to pay – for such a vehicle. About 61% said they are willing to pay from $750 to $1000 for the car, whereas only 16% are willing to pay more than $1000.

Reinforcement of the public attitude that car prices are too high came from bankers and finance companies; who were queried because of the important role they play in the distribution of motor vehicles. This group agreed with the car drivers that the price of such a light car should be about $1000. The financers as a group were of the opinion that present prices are too high to assure large volume production for the next few years.

Indications that a smaller, lighter car could be produced with adequate factors of safety, greater fuel economy, and at a lower price came from automobile engineers, to whom a questionnaire was sent to get their reactions to the problem.

This group emphasized, however, that costs will not be reduced by substituting aluminum or magnesium for iron and steel. The former costs about 24¢ per lb and the latter, 6¢ a lb. Such a substitution would represent an increase in cost of about $300 plus the additional costs in labor due to fabrication of the lighter materials. The final result, therefore, in reducing weight 1000 lb would be to increase cost 35-50% over that of the heavier car made of iron and steel. While there might be a reduction in weight for a car of equal size through the use of lighter materials, experience shows it would require 6-8 years of lower operating costs to make up the difference in initial cost.

High-Tensile Steel Possibilities

Low-alloy, high-tensile steels prolong the life of automobile parts by resisting corrosion better than carbon steels, another speaker said, and they have a strength that can be attained in straight carbon steels only at the expense of ductility, toughness, and weldability, due to the large carbon requirement.

These qualities make them worth the higher cost in suitable applications, he indicated, depending upon service requirements, competition, and other factors.

Fabrication of the low-alloy steels is different from that of carbon steels, he admitted; in fact, even the dies used for low carbon steel must be modified before they can be applied to high-tensile steels, and in some cases higher pressures and currents are needed to weld them.

For instance, a carbon steel of 75 Rockwell B would be so lacking in plasticity that almost anyone would deem the making of the simplest fender from this material an impossibility. However, it appears that a low-alloy, high-tensile steel of 75 Rockwell B is quite suitable. In fact, it was reported that several million fenders of one design have been made of such low-alloy, high-tensile steel, with less than 0.5% breakage. Hence, it seems that reasoning from the common criterion of hardness, tensile strength, or yield strength based upon experience with carbon steels leads to hopeless conclusions.

Monocoque Bus Structure

The almost complete absence of structural failures among modern buses using the monocoque construction – even during the war when they were loaded as high as 300% of rated capacity – was ascribed to the soundness of this type of construction.

The monocoque construction, first developed for buses in the late twenties, was reported to have gone through a period of evolution when failures of a startling nature sometimes occurred. It was found that the trouble lay, at least in part, in the fact that the skin was doing the work of carrying the load whether it was designed to or not. It seems that these failures were soon turned into knowledge and better construction, so that the monocoque structure demonstrated that the skin could be made to carry almost all the load. Today, the author said, panel failures are almost unheard of.

In addition, he explained that many of the early types had unnecessary weight and were too costly to build. In fact, according to the speaker, it wasn't until the bus designer borrowed the solid steel roof structure from the passenger-car engineer that the construction was really successful.

In the design of a monocoque type of bus, he pointed out that the engineer should first build a skeleton similar to the bones of the body. This skeleton must support the localized load imposed upon it, he said, and then must transmit that load by the most direct route to the main load bearing structure, which is the panel or skin. He added that it must also preserve the alignment of the skin and keep it from buckling under the imposition of a load.

One of the important problems was said to be that of keeping the skin in the proper position. Riveting it to positioning members was one method reported to solve this problem.

Important also is the design of the floor, for it was said to serve not only as the support of the primary payload but, when properly anchored, also as an enormous gusset, keeping the bus from parallelogramming, at the same time allowing a certain amount of flexibility.

It was pointed out that a certain amount of flexibility is needed in the structure, just enough to keep the bus from breaking up as it passes over uneven terrain and yet not enough to permit any of the component parts to deflect to near their elastic limits.

POWERPLANT Men See New Engines Bring New Problems

Based on discussions and seven papers presented at three Aircraft Powerplant sessions under chairmanship of **A. T. Colwell, William Littlewood,** and **Arthur Nutt** . . . "Prescribed-Centrifugal-Stress Design of Rotating Discs," by **C. M. McDowell,** Packard Motor Car Co.; "Ceramic Bodies for Turbojet Blades," by **R. F. Geller,** National Bureau of Standards; "High-Temperature Ceramic Coatings for Molybdenum and Certain Uses for Coated Molybdenum," by **W. N. Harrison,** National Bureau of Standards; "Stress Investigations in Gas Turbine Discs and Blades," by **S. S. Manson,** National Advisory Committee for Aeronautics; "Direct Injection," by **J. T. Marshall,** Bendix Productions Division, Bendix Aviation Corp.; "Full-Scale Engine Performance Characteristics of Aviation Safety-Type Fuels," by **W. J. Sweeney, J. F. Kunc, Jr., W. C. Howell, Jr.,** and **O. G. Lewis,** Standard Oil Development Co.; and "The Ramjet as a Supersonic Propulsion Plant," by **W. H. Goss** and **Emory Cook,** Johns Hopkins University . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

THE Aircraft Powerplant sessions dramatized the fact that in turning from reciprocating engines to gas turbines and even ramjets, engineers have not hit upon completely simple, troublefree powerplants. They have just exchanged traditional problems for new ones.

With the gas turbine powerplant, the big problem now is how to make the turbine strong enough to withstand terrific stresses at extreme high temperature, yet light in weight.

With the ramjet, aerodynamic and thermodynamic difficulties are more than compensating for the mechanical simplicity of the powerplant.

With the reciprocating engine, there is still the old question of how to bring fuel to air, and whether low-volatility "safety" fuels are worth while.

The fresh problems are being licked by renewed exploration of engineering fundamentals – fundamentals such as physical properties of ceramic materials, stress analysis of rotating discs, and principles of combustion processes.

Ceramic materials are being investigated because turbine strength is not a problem to be solved by resorting to highly heat-resistant steel alloys. Such alloys depend on elements produced in quantity only outside this country.

A porcelains expert reported that the refractory porcelains developed during the last few years are definitely promising. There seems no doubt that, with regard to strength, porcelains can replace metallic alloys at temperatures above 1500 F. Below 1900 F, porcelains have excellent resistance to creep, and they do not enter that stage of creep where rate of creep increases with time. In fact, they appear to become more resistant to creep under prolonged loading.

Still to be determined is whether these porcelains – and those to be developed – will have the necessary resistance to thermal and mechanical shock required for turbine blade service. Either way, it is practically inevitable that porcelains will replace metals in other high-temperature applications in powerplants.

Reason why porcelain coating of molybdenum is being studied is that the coating prevents oxidation of the molybdenum. Unfortunately, although molybdenum is plentiful and it has a high strength even above the melting point of steels, it also oxidizes very readily if exposed.

Porcelain-coated molybdenum specimens showed no oxidation after being held 70 hr at 1650 F. Coated pitot tubes have been used in development work on ramjets at 3000 F. The coating was sufficient protection for short-term use (15 to 45 min) at 3000 F.

Spark-plug manufacturers assured turbine men that it would be possible to fabricate ceramic blades, but no one expects that blades and disc will be fabricated as one piece, either of ceramics or of metal.

On the stress analysis side of the picture, data the NACA has amassed show that stresses in disc rims exceed the elastic limit in operation so that plastic flow takes place. With discontinuous rims, such as those where fir-tree attachments are used, plastic flow is not harmful. But in continuous rims, such as those where blades are welded on, plastic flow induces residual stresses and subsequent cracking in the rim when it returns to room temperature after operation.

The NACA has studied four ways to reduce residual stresses and rim cracking.

1. Disc cooling;
2. Incorporation of stresses into the disc during its fabrication that will counteract the residual stresses;
3. Drilling of holes in the rim, just inside the blade-root circle;
4. Cutting radial relieving slots in the rim.

A number of the discs which NACA has studied have been overdesigned; that is, the disc contains an excessive amount of material. A stress analyst came up with a method of calculating the contour of the lightest-weight disc which will withstand

design stresses. Chief advantage of the method is that it is logical and direct – it is not a trial and error solution. A contour can be calculated in about 16 hr, according to the originator of the method.

First step in this "prescribed-centrifugal-stress" method is to set up curves of compatible radial and tangential stresses, using Stodola's equation of compatibility and known boundary conditions. Then stress values for a number of stations are substituted in Timoshenko's equation for the equilibrium of a particle in the disc, and the equation is solved for disc thickness. From these values, the disc outline can be plotted.

The method does not account for thermal stresses – although it might be possible to modify the method to include them. Instead, the speaker recommended that probable values of thermal stresses be kept in mind when deciding on the acceptable shape for the curve of centrifugal stresses and on their maximum values.

The really challenging problems in the development of the ramjet involve flame stabilization in high-speed streams, mixing in gas streams, and combustion in general, according to two authorities. They pointed out that since flame speeds are of the order of a few feet per second, it is apparent that the key to ramjet burner design is a mixing and flame-stabilizing system which will permit these slow flame fronts to reach and consume all of the combustible mixture as it passes by at high speed. The mixture in an average ramjet combustion chamber passes through the chamber in about 0.005 sec. Effective combustion must occur within this time.

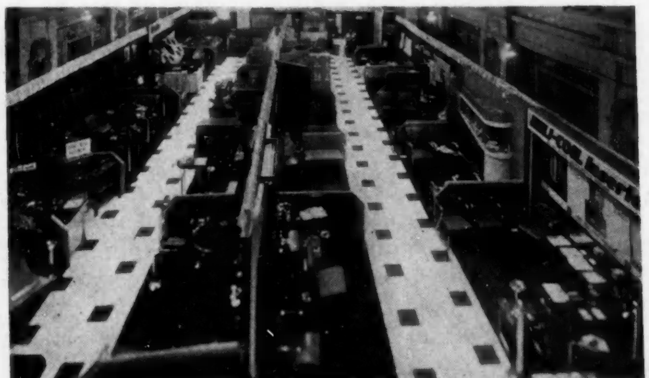
Serious obstacle to the developmental testing of ramjets is the airflow requirement. For ground tests, an air mass flow equal to that in flight must be supplied to the combustion chamber by an auxiliary air supply at stagnation pressures equal to those recovered by the diffuser. With available air supplies, testing can be carried out only for very small models at low Mach number, or at conditions corresponding to flight at very high altitudes.

Unless the ramjet testers can take over all of Hoover Dam's power, they will have to substitute brains for brawn for full-scale sea-level testing. The best hope for extending sizes and speed ranges beyond those where laboratory testing facilities become impractical for full-scale work, is an insight into the basic aerodynamic and thermodynamic processes. Ramjet scaling from small model to large is a combustion problem, not a mechanical problem.

For sustained propulsion at supersonic speeds, no other powerplant can compete with the ramjet, the speaker said. Being expendable, the ramjet is an excellent choice for those military applications which demand high speed on a one-way trip – ramjet specialists are talking about Mach numbers of 2.5 and 3 in connection with flight velocities.

For reciprocating engines, direct injection is the new and quite satisfactory answer to the problem of leading fuel to air. Already, more than 22,000 9-cyl pumps have been built for military aircraft such as the B-29, and more than 2000 have been built for commercial airlines' Constellations, it was reported.

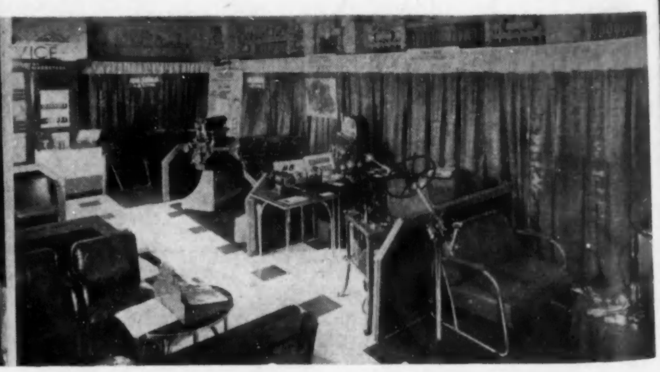
One speaker described in detail the Bendix pump for the R-3350 engine. He startled his audience by



1948

ENGINEERING DISPLAY

More than 4000 engineers visited the 50 technical exhibits at SAE's 1948 Engineering Display held in conjunction with the 1948 Annual Meeting. Both attendance and number of exhibitors equaled the all-time high established last year.



talking about tolerances in millionths of an inch. Although the pump is such a delicate piece of equipment, he said that airlines' experience has shown that pump overhaul is neither excessively expensive nor too involved for personnel capable of aircraft engine overhaul.

Service reliability of direct injection depends on precision in manufacture. It is the precision requirement that makes first cost high. On the other hand, the pump manufacturer reports that direct injection saves 2 to 3% of the fuel in overall airplane operation, and increases airline payloads 200 to 300 lb because of the decrease in fuel load. Besides, detonation-limited performance with a given fuel is better with direct injection than with ordinary carburetion.

Other advantages claimed for direct injection are, besides decreasing fire and icing hazards, that it gives better distribution characteristics and a smoother-running engine with less wear; and it eliminates the carburetor's time lag, thereby allowing more rapid acceleration.

Fuel experts brought out one more feature of direct fuel injection – it permits the use of low-volatility "safety" fuels. Remaining neutral on the question of whether any safety advantage results from use of "safety" fuels, the speaker and his co-authors concentrated on the performance characteristics of the safety fuels.

Satisfactory engine operation at warmed-up conditions can be obtained with these fuels. This they concluded from tests determining knock-limited performance, specific fuel consumption, and oil dilution characteristics of the low-volatility fuels.

The knock-limited performance data showed that, while increasing the aromatic content of low-volatility fuels blends from 20 to 50% results in improved rich-mixture performance, it markedly decreases the lean-mixture cruise rating.

At a heat content of 19,000 Btu per lb, minimum brake specific fuel consumption is about the same for low-volatility fuels and for conventional-volatility fuels. But consumption increases more rapidly for low-volatility fuels than for conventional-volatility fuels as heat content is decreased or as engine speed is increased. The low-volatility fuels' poorer showing on the fuel consumption score is due to their incomplete combustion, as evidenced by smoke.

Discussers accepted the speakers' word that safety fuel is a fuel, but they asked, "Is it safe?" Although the question wasn't settled, three points were made:

1. A bullet or a spark entering the vapor-filled space above the fuel in a plane's fuel tank is more likely to cause an explosion if the fuel is safety fuel than if the fuel is of conventional volatility. With ordinary aviation fuel, the mixture is too rich to explode, but with safety fuel, the mixture is lean enough to explode.

2. Safety fuel burns much less readily than ordinary fuel when it is spread over unheated bundles of scrap, similar to what might result from a crash.

3. Safety fuel ignites more easily from hot metal surfaces than does ordinary fuel. Safety fuel will ignite on metal at about 520 F, while the minimum ignition temperature is about 30 F higher for ordinary fuel.

Experts Discuss Helicopters and Air Conditioning of AIRCRAFT

Based on discussions and four papers presented at two Aircraft sessions under chairmanship of **P. E. Hovgard** and **A. L. Klein.** "Helicoper Controls for Pitch-Power Coordination," by **A. F. Donovan** and **Harold Hirsch**, Cornell Aeronautical Laboratory; "Helicopter Vibration Isolation," by **Bartram Kelley**, Bell Aircraft Corp.; "Design Considerations for Cabin Air Conditioning of the Boeing Stratocruiser," by **R. L. Linforth**, Boeing Aircraft Co.; and "Cabin Supercharger Design and Drive Systems," by **S. B. Sherwin** and **D. O. Moeller,** Stratos Corp. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

ALTHOUGH the aircraft activity's sessions looked into both the fundamentals of helicopter design and the fine points of cabin air conditioning, one concept stood out – no matter which the engineer is designing today, he is aiming at designing his unit to require only a minimum of the pilot's attention.

It is the engineer's job to make the pilot's job easier by arranging for automatic operation of aircraft equipment wherever that is possible and by designing each component for utmost reliability. Both sessions provided illustrations of how it can be done.

Applied to the helicopter, the minimum-pilot-attention concept was interpreted to mean that pitch should be correlated with power through a simultaneous, mechanical system adjusting pitch for those variations in torque which result suddenly from collective pitch change. Such a coordi-

nating system would keep rotor rpm within the prescribed operating limits, relieving the pilot from the duty.

Applied to air conditioning of transports, the concept has led Boeing engineers to design an air- and altitude-conditioning system for the Stratocruiser which meets all the physiological requirements, yet regulates automatically temperature, humidity, and pressure. The plane's operating personnel need only select the schedule of operations according to the flight plan. Designers of another pressurizing system have developed a fluid coupling to take power for their cabin supercharger off the engine pad and regulate impeller speed automatically so as to maintain constant cabin airflow.

Pitch-Power Correlation

Helicopter maneuvers often require the pilot to make sudden, large changes of main-rotor collective pitch. Changes in collective pitch require, in turn, a corresponding change in engine power. The engine throttle must be reset at once to meet the new power requirement or else the rotor speed will change dangerously.

The co-authors of a paper on pitch-power coordinating systems brought out that manual operation of independent pitch and throttle controls obliges the pilot to watch the rotor tachometer during maneuvers, the time when he should be concentrating on position, attitude, and other external factors.

Independent operation can be replaced, they explained, by interconnected pitch and power setting. They favored mechanical interconnection of the collective pitch and throttle system so that operation of the pitch lever simultaneously adjusts the throttle – although it would be possible (but more costly) to use manual operation of the throttle and connect the pitch setting through.

Aside from the sudden changes in collective pitch, fluctuations in air density and flight conditions bring about torque change, but these changes are small and gradual. Corresponding adjustments in power can be made either manually or by automatic servo throttle trimming.

For pitch-power correlation, the authors propose a dead-center bellcrank-link arrangement in the pitch system to linearize the parabolic pitch-torque relation of the rotor, together with a cam for linearizing the torque-throttle relation of the engine. The arrangement makes possible direct interconnection of the two control systems at the main pitch-throttle control stick. For the combined system, rotor rpm is substantially unaffected by change in rotor pitch.

Coordinating the systems in this manner adds very little cost, weight, and complication over that of independent pitch and throttle control.

Automatic servos can be added to the coordinated pitch-power control to maintain constant rpm in the face of changes in flight conditions. Slow servos, which are both light and relatively inexpensive, are adequate for good rotor control.

The elimination of vibration – always a factor in increasing general reliability as well as in reducing pilot distraction – is simplified in the helicopter because of the fact that helicopter rotor speed is held nearly constant in operation. Vibration can be isolated by rubber mounts and damping is unnecessary, where rotational speed is constant. The flexible-pylon helicopter is designed on this principle.

A Bell vibrations expert showed that the physical constants of the helicopter system can be chosen to minimize vibration from rotor unbalance, unequal drag, and variable blade lift. Bell isolates horizontal rotor vibration by means of rubber engine mounts. They have found that their blades happen to have just about the right flexibility to isolate vertical vibration. Therefore the rotor mount is rigid in the vertical direction.

The speaker reminded helicopter men that the theory of isolating vibrations excited by a periodic force applied at one end, such as rotor forces, shows that an intermediate mass in a mechanical system can be isolated from motion and an intermediate spring can be isolated from stress. Unfortunately, the mass farthest from the exciting force can never be isolated from motion and the farthest sping can never be completely protected from deflection. The last element in the chain will always receive a small amount of vibration. These facts presented in equation form by the speaker determine the optimum physical constants of the helicopter system.

Air Conditioning System

The Stratocruiser's air- and altitude-conditioning system not only regulates temperature, humidity, and pressure, but also rate of pressure change.

The cabin air temperature control is completely automatic and completely modulating. Heating is supplied to fresh air only. Cooling requirements are met with the recirculated air. Fresh air is heated both by the heat of compression as it passes through the engine supercharger and by gasoline-fired heaters. Two identical freon cooling systems, each having two compressors, take care of the cooling.

The master cabin temperature-sensing devices are located in the aft half of the main upper cabin. In the ducts supplying this area are devices which sense temperature and select the degree of heating or cooling needed.

Temperature in the other compartments is set by varying the ratio of fresh air to recirculated air. A balanced resistance bridge and a program motor operate valves leading into the chamber where fresh and recirculated air are mixed, regulating the proportion of heated fresh air to cooled or uncooled recirculated air.

The cabin attendant sets the humidity selector,

then the humidity control maintains the humidity level at the value set. A human-hair moisture-sensing element is equipped to energize one, two, or three electric heating elements in a steam generating unit. This steam is introduced into the cabin fresh air system downstream of the heaters.

Cabin temperature and humidity selectors are color coded to assist the cabin attendant in establishing the corresponding dry bulb temperature and relative humidity to provide the optimum cabin effective temperature.

Cabin pressurization is supplied by the engine supercharger. Pressure is controlled by two valves which restrict the discharge from the plane of used air to the volume of fresh air minus leakage. Together, the two valves provide variable isobaric and fixed maximum differential regulation of pressure, the differential function being able to override the isobaric function. This means that if a cabin altitude of sea level has been selected, the controls will maintain this value up to an airplane altitude of 15,100 ft. There the absolute pressure difference between the cabin and ambient pressures reaches the design value of 6.55 psi. Further increase in airplane altitude is followed by increase in cabin pressure at approximately the same rate of ascent as the aircraft. But cabin pressure remains 6.55 psi higher, so that when the airplane is at 30,000 ft, the cabin is at 8000-ft pressure.

Because the selective isobaric feature incorporates a rate-of-change selector, the cabin need never ascend or descend at a rate higher than desired. For instance, a plane climbing 100 fpm would reach 30,000 ft in 30 min. Assuming take-off at sea level, the flight crew might select a final cabin absolute pressure of 8000 ft to be obtained at a rate of 266 fpm, thus arriving at the 8000-ft cabin altitude when the plane reaches 30,000 ft. Once the crew has made the selection, the rest is automatic.

For altitude-conditioning systems which do not use the engine supercharger to maintain cabin pressure, a pair of engineers described their cabin supercharger with fluid coupling. The entire drive system consists of a primary step-up gear train, a hydraulic coupling, and a secondary step-up gear train to the supercharger impeller shaft. Automatic airflow control is dependent on the fluid coupling.

Impeller speed – and therefore airflow – is a function of the oil level within the coupling. Oil supply to the coupling depends on engine speed only, and no attempt is made to control it. Outflow is controlled so that the impeller shifts to the speed which affords constant cabin air supply.

Automatic outflow control is accomplished by a device which senses the differential across a venturi through which the cabin airflow passes.

F&L Engineers Consider Bad Effects of Extreme Operating Temperatures

Based on discussions and four papers presented at two sessions on Fuels and Lubricants, under chairmanship of **H. L. Moir** and **J. M. Campbell** . . . "Preignition and Its Deleterious Effects in Aircraft Engines," by **A. Hundere** and **J. A. Bert**, California Research Corp.; "The Component Parts of Gasoline," by **C. E. Boord**, Ohio State University; "Engine Knock and Molecular Structure of Hydrocarbons," by **W. G. Lovell**, Research Laboratories Division, General Motors Corp.; "Deposition and Wear in Light Duty Automotive Service," by **R. B. Greenshields** and **N. Kendall**, Shell Oil Co.; and "Effect of Engine Operating Conditions on Oil Contamination and Sludge Formation," by **C. W. Georgi**, Quaker State Oil Refining Corp. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

OFTEN it isn't the fuel or the lubricant – it's the engine operating temperature that causes trouble – according to interpretations of new research results reported at the F&L sessions.

With very high engine temperatures, even "super fuels" will knock at fairly low compression ratios. And localized high temperatures in the combustion chamber cause pre-ignition of the fuel-air mixture, a phenomenon which doubles the heat load on an engine and can cause failure in a matter of seconds.

Too low temperatures are largely responsible for engine sludge formation, oil contamination, and wear experienced in light-duty operation of trucks and passenger cars, it appears.

When it comes to high temperatures, paraffins as a class of hydrocarbons are not "sensitive," but some of the paraffins of higher antiknock value are exceptions. Their knock-limited compression ratio drops as temperatures prior to combustion are increased. In fact, no fuel component better than iso-octane has been found for use under very-high-temperature operating conditions.

Therefore, engines designed to take advantage of fuels of very superior potential performance must avoid extreme high temperatures. This was one of a number of conclusions reached after nine years of work by the gigantic API Research Project 45.

Besides making engine combustion studies, the Project has synthetized and purified individual hydrocarbon compounds and measured their physical and thermal properties. The investigators feel now that it is possible to synthetize every one of the compounds known to be in gasoline. Already 176 compounds have been obtained in pure form. More than 200 have been engine tested, some under as many as 29 different sets of operating conditions.

Increased operating temperatures and increased tetraethyl lead content of the fuel were two factors blamed by a pair of fuels experts for the increased prevalence of failures by pre-ignition in aircraft engines.

Surfaces capable of providing pre-ignition hot spots are those of the spark plug, combustion chamber deposits, and exhaust valves, they said.

The spark plug must run hot enough under the mildest conditions to burn away carbon, and it must run cool enough under the severest conditions to prevent pre-ignition. The fuels men found that pieces of the spark plug insulator cracked loose and lodged between the electrodes. The pieces are thermally insulated from the spark plug body, so that the heat they acquire is not dissipated and they readily cause pre-ignition.

In engines burning leaded fuels, combustion chamber deposits contain lead compounds as well as carbon. One of the lead compounds, lead sulfate, does not decompose until a temperature of 2135F is reached; therefore it can attain in the solid state the temperatures necessary for preignition. Furthermore, it seems likely that some of the lead compounds deposited may have a catalytic effect that would lower the temperature required for pre-ignition.

The exhaust valve, like the spark plug electrode, operates at temperatures close to the pre-ignition level under the severest operating conditions. The relatively large area and the normal presence of deposits on the valve crown aid in attainment of pre-ignition temperatures.

The low end of the operating temperature range causes trouble in automobile engines. Because radiator cooling capacity must be sufficient to cool the engine under high loads on hot days, it often overcools the engine under other conditions. Difficulties with sludge-formation, wear, and oil contamination that are usually blamed on the oil are actually due to operating temperatures that are too low, lubrication engineers reported. And they added that cylinder wall temperatures may be undesirably low even though the dashboard temperature gage, which shows cylinder head temperature, may register satisfactorily high.

Subsequent engine operation at more elevated speed and higher operating temperatures bakes these soft sludges to hard, adherent deposits.

Another speaker also linked engine deposits with low-temperature operating conditions and went on to show how they affect oil dilution and wear. The water of combustion condenses on the cool cylinder walls and passes down into the crankcase along with unburned fuel and carbon dioxide from the combustion chamber.

One of the best approaches to the cure of the whole problem, the fuels and lubricants experts agreed, is to raise water jacket temperatures to the 160-180F range. And engine owners and operators should be educated on the need for keeping the thermostat in good working order.

Other engine improvements advocated were improved crankcase ventilation, fuel metering systems capable of providing leaner mixtures at idling and low speeds, and more efficient oil filtration.

Future lubricating oil developments, it was said, must undoubtedly be in the direction of increasing the ability of the crankcase oil to hold in suspension the low-temperature degradation products of the fuel. Another oil improvement may well be increased ability to neutralize the corrosive acids.

LIGHT PLANE ENGINE OIL

Continued from page 31

and ring belt carbon formation. The test is accelerated to bring out the oil's inherent weakness which would be experienced in the field only after extended flight tests.

A. P. Texada and R. J. Greenshields, Shell Oil Co., have set up similar laboratory engine tests. But rather than attempting to simulate service conditions, they use a Franklin 65-hp engine to evaluate the oil's oxidation stability and detergency with regard to lacquering and piston condition.

Closely controlled endurance tests, says J. W. Kinnucan, Continental Motors Corp., have indicated a definite critical operating temperature. Above it accelerated ring sticking takes place and below it little trouble is encountered. Addition of some detergents to oils tested raised this critical temperature.

Timeliness of this kind of work is stressed by J. D. Munsell and N. G. Eder, Kendall Refining Co., in a discussion of valve sticking and piston-ring deposit problems currently besieging light aircraft operators. They point out that prior to the war, this class of aircooled engine operated with minimum maintenance for 500 to 800 hr before requiring a major overhaul. For the past year or two these same engines have been unable to operate as long as 250 hr without repeated top servicing in many cases.

News of Sections

cont. from p. 65

velopment, and that further steps will be slow in coming.

Student Winners

Prof. Charles Worthington Phelps of Yale's School of Engineering, who had acted as chairman of the judges, announced the winner of the Section's student paper contest for the 1946-1947 season, John H. Robinson, for "Introduction to Statistical Quality Control." Robinson was a student of University of Connecticut, and now works for General Electric Co.

Describes Construction of Ancient and Modern Roads

by C. W. SISSMAN, JR., Field Editor

SALT LAKE CITY Group, Dec. 8 – Ancient roads built by the Amorites, Egyptians and Romans, by today's standards, would probably cost $200,000 per mile to build. George H. Gearhart, of Robinson Machinery Co., took Section members back to ancient times and forward as far as highway engineers have looked, in a survey of past, present and future road building.

These first roads, he said, were made by excavating a trench the entire length and width of the road, then placing four layers of material in the trench to give it a thickness of about 4 ft. The layers were large flat stones set in lime mortar; small broken stones mixed with lime; still smaller stones, gravel and lime; and a pavement of irregular stones about 6 in. thick, closely joined and carefully fitted.

Six Helicopter Papers Form Successful Symposium

by A. M. MILEY, Field Editor

PHILADELPHIA Section, Dec. 10 – An all-day helicopter symposium, including five papers and a report on SAE-sponsored helicopter design activities, made one of this Section's best meetings.

On hand to insure its success were Lee Douglas, of Kellett Aircraft Co., to speak on "Exhaust Cooling of the XR-10 Helicopter Engines"; Warner T. Cowell, Gleason Works . . . "Bevel Gear Test Experience"; L. A. Hilles, Fafnir Bearing Co. . . . "Bearings in Action"; Miller A. Wachs, Sikorsky Aircraft Co. . . . "Accelerated Testing of Gear Drive Mechanisms"; and

Frank N. Piasecki, Piasecki Helicopter Corp. . . . "Engineering Problems of the Helicopter." R. H. Prewitt, of Prewitt Aircraft Co., made a report as chairman of the SAE Helicopter Activity Committee.

Douglas described ejector cooling as a promising approach to eliminating most of the cooling losses to which helicopters are subject, and as a means of substantially increasing payload. Cooling the XR-10 helicopter's engine by fan rather than ejection cooling, he said, would result in a loss of about 6% in bhp. Converting this loss to lift in a 1050-hp helicopter weighing 11,000 lb gross gives a loss in lift of 630 lb, or more than 20% in useful load.

Cowell showed a series of slides illustrating various stages in the development of two bevel gear test assemblies to successfully carry high aircraft loads for the 150 hr required by the Army Air Forces. Results showed that the rigidity of the mounting reduces stress on gear teeth. Since fatigue life of gear teeth varies inversely as the seventh power of the stress, he said, design engineers have a wonderful opportunity to reduce size and weight of gear drive assemblies.

Important among wear aspects of gears are pitting (caused by overloading, interferences or wrong tooth shape, misalignment of mountings, improper assembly, or, in high speed gears, impact loading caused by inaccuracies of the gears themselves); abrasion, scratching, scoring, or galling (caused by contamination of the lubricant, poor lubrication, serious load concentration, or plain overload); tooth breakage (from overload or fatigue).

It was the development of the helicopter with its multiplicity of cyclical oscillatory motions and resultant cyclical deflections and vibrations that brought the friction oxidation problem to the forefront and started really serious study. In 1939, Hilles reported, a relatively poor bearing had been found to perform better than the best quality precision bearings when it was lubricated with certain lithium base greases. Some of these greases were 30 times as good as those previously used in aircraft control bearings.

Friction oxidation, he said, is the ordinary mode of failure for races in reversing applications, and occurs when there is a simultaneous oxidation of the grease (which becomes acid) and oxidation of the metal in the race, causing removal of considerable volume of metal from the race under the ball contact. Iron oxide mixes through the grease and forms a lapping compound that speeds up the cycle of deterioration. He described the extensive test program undertaken by Fafnir, and urged close collaboration between aircraft and bearings engineers on bearing selections, particularly in oscillating and vibrating applications.

Not only should helicopters be subjected to endurance ground and flight testing to prove transmission systems, Wachs reported, but certain elements of the transmission system should be given separate bench tests – either in anticipation of possible difficulties to be experienced during the endurance run, or after such difficulties have developed.

Successful helicopter design and development, he said, probably will depend on carrying out five steps:

1. Careful design based on accurate analyses and experience gained from previous models;

2. Bench tests of basic elements, particularly parts which operate in rotary or oscillatory motions and are subjected to alternating loads;

3. Endurance tie-down tests of the complete helicopter;

4. Accelerated service flight tests;

5. Careful and continuous checking of field service records obtained from the customer. Customers, he said, always find ways of punishing the product that were not foreseen in design or subsequent development testing.

Wachs described elements of a thorough test program, pointing out the important and supplementary nature of each step.

Agnew E. Larsen, of Glenn L. Martin Co., acted as chairman of the afternoon session. Dr. Alexander Klemin was chairman of the evening session, when Frank N. Piasecki presented his paper on "Engineering Problems of the Helicopter" (See SAE Journal, December, 1947, p. 55).

Ground Problems Multiply With Growing Plane Size

by J. W. VOLLENTINE, Field Editor

CENTRAL ILLINOIS Section, Nov. 24 – "A rapid movement to secure aircraft bases for the establishment of air supremacy and the subsequent movement of heavier fighting equipment is more likely to be the order of a future conflict than the much-publicized push-button, atomic, and bacteria warfare." So said Brig.-Gen, S. D. Sturgis, Jr., air engineer of the Army Air Forces, speaking at this meeting on "Air Power as Affected by Airdrome Construction."

After the Japanese succumbed and initial Armistice terms had been dictated to their emissaries, he said, General MacArthur supplemented his instructions by radio message to the Japanese authorities in Tokio. Among such messages was a directive for the Japanese to provide 10 motor patrols (road grader) at Atsugi airdrome coincident with the arrival of initial airborne elements of our occupation forces. The Japanese respectfully replied that it was impossible for them to comply because only three such

graders were known to exist in the entire empire – and these were not self-propelled.

Just before World War I, rapid improvement in motor vehicle equipment overran road construction equipment and techniques. This, in part, caused the loss of mobility which motor vehicle equipment could have given the Army. Between wars, intensive development brought forth much construction equipment aimed primarily at road construction.

At the outset of World War II this equipment developed by free enterprise coped satisfactorily with airdrome landing field construction and maintenance for any aircraft then envisioned, including the B-29. With the tremendously increased size of aircraft (the B-36 for instance) problems of airdrome construction take on new aspects. When design of planes and design of airdromes are out of balance, future mobility and flexibility of air power itself are threatened.

There is no economic impetus for developing construction machinery and methods that will produce surfaces required for aircraft of the B-36 type or larger, since such loads normally are not employed in other types of industry.

The B-36, Sturgis said, weighs 300,000 lb loaded – 8½ times the weight of the C-47; 5 times that of the B-17 or B-24; and over twice that of the B-29 – and heavier aircraft are in the offing. Aircraft manufacturers report that man-hours per pound to construct a plane, and cost per ton to haul payload, keep their downward trend up to 800,000 lb aircraft. The hitch is on the ground, where it is necessary to provide take-off, landing, and maneuver facilities for such loads.

Engineers are faced with the problem of designing pavement for wheel loads of 75 tons or greater. They are asked for continuous footing – a pavement for moving and vibratory loads of that magnitude. A special testing rig, designed and constructed for up to 150,000 lb applied to the single center wheel, showed that no slab less than 20 in. thick is structurally competent.

Pressure by pavement engineers and limitations set by tire and landing gear design have forced the use of multiple-gear landing wheel. While this type of landing gear is a partial solution of the construction problem in permanent airdromes, aircraft designers interested in saving weight and wing space have furthered the development of high pressure tires. The contemplated 170-psi inflation pressures, Sturgis pointed out, will cut all but the strongest surfaces to ribbons.

Concrete alone for a B-36 airdrome would cost about nine times as much as a similar B-24 installation, and 2½ times one for a B-29.

There has been a natural tendency

to establish bases as far forward as possible in order to be within fighter range and in better bombing range. In spite of some thinking along the lines of very heavy bomber bases for operational uses being located in the United States, Sturgis feels that the same aggressive tendency to position air bases near the enemy will continue.

Transportation and seasonal construction limitations will make highly impractical, if not impossible, the construction of additional very heavy bomber bases for the use of strategic air forces, particularly in the Arctic and Subarctic. It takes 20 Victory shiploads of cement to build a B-36 airdrome. By air, it would require 12,000 trips with a C-54. Six times as much sand and gravel are required.

The air force looks hopefully at the track landing gear which has been used successfully for attack bomber aircraft. It is hoped that this device can be developed to obviate rigidly constructed runways. Its great weight and bulk are undesirable from the aircraft-designer's standpoint, but if mobility of the Air Force can be maintained, it is felt that this would far outweigh reduced performance.

The track landing gear is designed to use rubber belts for the contact surface, supported by a flexible bogey arrangement similar to that used on tanks. The entire mechanism is mounted on a standard shock absorber arrangement. Design would, of course, vary with the load to be carried and the type of aircraft. No difficulty has been experienced with excessive belt wear or with bringing the track arrangement up to speed during landing.

Calls Ramjet Greatest Engineering Problem Yet

by A. M. WATSON, Field Editor

SOUTHERN NEW ENGLAND Section, Dec. 3 – More advanced engineering than we have ever known will go into development of ramjet prototypes, Dr. Emory Cook told this meeting, adding that its development for other than military purposes is extremely impractical. Cost of test units would be so tremendously expensive that engineering must be perfect the first time, and also, unfortunately, based largely on extrapolation into the regions in which tests cannot be made. Any other process would be similar to destroying a B-29 airplane for every test necessary to develop a reciprocating engine.

Cook told of sample tests made by the Applied Physics Laboratory at Johns Hopkins University, where he has worked on the proximity fuse and anti-aircraft directors, and is now connected with the Bumblebee Project on guided missiles. Tests based on a 6-in. diameter, he said, indicated that a Mach 3 at sea level with a unit 4 in. in diameter would require the expenditure of some 2,000,000 hp. The ramjet therefore presents a tough combustion problem, even though it is a superlative type engine.

The vast turbo-electric powerplants now in use, he said, were developed through the experience of many years, while the development of ramjets of comparable power output has so far taken place in a mere two years. And it must be similarly accelerated for purposes of military preparedness. Cook believes the ramjet will become more and more necessary, as a propulsive means of military attack and defense. A particularly valuable use would be in guided missiles, which must be developed not only for purposes of attack, but also as a means of defense against such weapons as the V-2.

Thus the field presents a highly-challenging picture for the engineering profession. Cook emphasized his

high regard for the projects now under way centered about M.I.T. and Johns Hopkins, in which the aircraft industry has a high degree of participation.

Rocket's Efficiency Augurs Future Usefulness

by J. H. CARPENTER, Field Editor

WILLIAMSPORT Group, Jan. 5 – Present rockets are highly developed versions of those the Chinese used in 1200 A.D. when flaming arrows were used with a burning substance in the arrow tail, said Arthur W. Robinson, Jr., project engineer of guided missiles for General Electric Co.

The rocket's principal advantage is a terrific power output from a small, light-weight unit. The V-2 develops about 350,000 hp from a powerplant weighing 2000 lb. Actual total weight of the V-2, he said, is 14 tons – including 9 tons of fuel, all of which is burned in the first 60 sec of flight, when the rocket has reached a speed of 3000 mph, sufficient to raise it to an altitude of 100 miles. Even at this speed, acceleration does not exceed 4.5 g.

Robinson showed slides of the V-2's combustion chamber fuel tanks, fuel pump and motor, and other components. The fuel pump motor, a turbine burning hydrogen peroxide and sodium permanganate, drives a double fuel pump with impellers at each end of the main shaft, to pump liquid oxygen and alcohol from the storage tank to the combustion chamber where burning occurs automatically when the two liquids meet.

The missiles are launched vertically, and their course set after launching by radio control of carbon fins in the jet stream. Two sets of fins control the trajectory, two control yaw, and together they control roll.

Robinson explained that V-2 testing at White Sands is being conducted to obtain information on cosmic rays at altitudes otherwise unattainable. The warhead space is filled with instruments to transmit desired information to ground crews who pick up and record it.

Trips to the moon, he said, probably won't be made for some time despite newspaper predictions. Such a trip would be possible, however, by utilizing multiple-stage rockets – rockets inside larger rockets. The major rocket would be fired and proceed to a predetermined speed and altitude, then a second smaller unit would be fired from the nose of the first, and so on to the smallest one which could carry no payload. However, he feels that improved fuels and design may make such a trip more feasible in the future.

Student Branch News

Continued from p. 57

controlled by a tuning fork. The accuracy of the fork is 0.01% when a temperature correction is supplied. Boller cited this instrument as an example of his design philosophy: any instrument can be broken down into compact, individual units. This facilitates assembly, repair, and redesign of a single portion if necessary.

- The "instantaneous heat capacitometer," an instrument developed for the jet propulsion laboratory operated by Caltech. The instrument supplies continuous records of specific heat with increasing temperature. Material to be tested is placed in a nickel-lined furnace that heats to 2600 F. When the temperature of the furnace increases, the temperature of the specimen lags somewhat. At any chosen furnace temperature, the heat required to bring the specimen up to furnace temperature will give a measure of the specific heat. This auxiliary heat is

supplied by an element within the specimen, and is measured by the voltammeter method.

Boller presented students with some of the philosophy needed to operate a small engineering firm. Use of quality instruments made by other firms, he said, is a healthy practice. Particularly important are neatness and compactness of design. A parting and helpful suggestion was that of keeping very accurate cost records so that future estimates of job cost may be made with more precision.

—by Warren Marshall, Secretary.

About SAE Members

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MERLE F. JACKSON is now principal of the Tonovay Grade School in Eureka, Kans.

Now working for the Chrysler Corp. as a project engineer, **JAMES M. SCOFIELD** had been with the General Motors Corp.

GEORGE A. BLEYLE, chairman of the SAE wartime Committee S-4, Cold Starting Requirements for Aircraft Engines, and an engineer at Wright Aeronautical Corp., is returning to Ladd Field, Fairbanks, Alaska, this winter for further studies and observations.

Recently resigning from his post at the Fisher Plastics Corp. in Newton, Mass., **N. J. RAKAS** has become connected with National Automotive Fibres, Inc., Detroit. He will be in charge of research and development of plastics and synthetic textiles as applied to automotive applications.

GOMER H. REDMOND is now a production engineer with the Scandinavian Airlines System in Seattle, Wash.

JAMES H. BARNES has been appointed assistant to the head of the Body Department of the Purchasing Office at Ford Motor Co. He had been assistant sales manager of the Automotive Division of the Budd Co. since 1943.

E. ZUMSTEG, formerly sales and service manager with General Motors Java in Batavia, is now executive assistant at General Motors Suisse, in Bienne, Switzerland.

Previously affiliated with Wright Aeronautical Corp. in Wood-Ridge, N. J., **FREDERICK S. SHERWIN** recently became a sales engineer with the Files Steam Specialty Co. in Boston.

OBITUARIES

LEO C. CONRADI

Leo C. Conradi, technical director of research and development for the Standard Steel Spring Co., Coraopolis, Pa., died at his home in Sewickley, Pa. on Dec. 4. He was 57.

An SAE member since 1923, he was formerly technical research manager, International Business Machines Corp. in Endicott, N. Y. He had been with the Standard Steel Spring Co. since 1942.

SIGURD B. JACKSON

Sigurd B. Jackson, who had been manager of the Chemical Department of the General Electric Co. in Detroit for the past 30 years, passed away on Dec. 22.

He had joined the SAE in 1927.

CHARLES W. SIMMONS

Charles W. Simmons, sales manager of the Clutch Division of Lipe-Rollway Corp. in Syracuse, N. Y. died suddenly on Nov. 21 after a brief illness.

He was graduated from Cornell University in 1923 as a mechanical engineer. Upon completion of his under-

graduate studies, he joined the Ingersoll Rand organization, and in 1935 was employed by the Lipe-Rollway Corp.

NORRIS R. BUCKINGHAM

Norris R. Buckingham, long associated with the drop forging industry, passed away on Dec. 12, from injuries received in an automobile accident.

At the time of his death, he was vice-president and general manager of the Atlas Drop Forge Co., Lansing, Mich. He started to work for this company in 1916, at the age of 17.

Change of Address

So that your SAE mail will reach you with the least possible delay please keep SAE Headquarters and the Secretary of your local Section or Group advised of any changes in your address. Such notices should be sent to:

1. **Society of Automotive Engineers, Inc. 29 West 39th St., New York 18, N. Y.**
2. **The Secretary or Assistant Secretary of your Section or Group at the addresses listed below:**

• **Baltimore**
R. D. Taber, Koppers Co., American Hammered Piston Ring Division, Bush & Hamburg Sts., Baltimore 3, Md.

• **Buffalo**
L. D. Bevan, Bell Aircraft Corp., P.O. Box 1, Buffalo, N. Y.

• **Canadian**
C. E. Phillips, Perfect Circle Co., Ltd., 175 Wicksteed Ave., Leaside, Ont., Canada.

• **Central Illinois**
I. E. Howard, Phillips Petroleum Co., 2520 S. Washington St., Peoria 5, Ill.

• **Chicago**
F. E. Ertsman, Hendrickson Motor Truck Co., 3538 S. Wabash Ave., Chicago, Ill.

• **Cincinnati**
W. A. Kimsey, R. K. LeBlond Machine Tool Co., Madison Ave. & Edwards Road, Cincinnati 8, Ohio.

• **Cleveland**
(Miss) C. M. Hill, 7016 Euclid Ave., Room 210, Cleveland 3, Ohio.

• **Dayton**
D. D. Bowe, Aeroproducts Division, GMC, Municipal Airport, Dayton 1, Ohio.

• **Detroit**
(Mrs.) S. J. Duvall, Detroit Office, SAE, 100 Farnsworth Ave., Detroit 2, Mich.

• **Hawaii**
J. C. McLaughlin, 525½ 18th St., US Naval Housing, Area 3, Pearl Harbor, T. H.

• **Indiana**
R. P. Atkinson, Allison Division, GMC, Indianapolis, Ind.

• **Kansas City**
H. F. Twyman, Civil Aeronautics Administration, Power Plant Engineering Division, Department of Commerce, 414 E. 12th St., Kansas City, Mo.

• **Metropolitan**
(Miss) J. A. McCormick, Society of Automotive Engineers, 29 West 39th St., New York 18, N. Y.

• **Mid-Continent**
R. E. Edwards, Halliburton Oil Well Cementing Co., Box 471, Duncan, Okla.

• **Milwaukee**
G. J. Haislmaier, Young Radiator Co., Racine, Wis.

• **New England**
W. F. Hagenloch, Lenk, Inc., 1305 Boylston St., Boston 15, Mass.

• **Northern California**
H. R. Porter, Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif.

• **Northwest**
C. F. Naylor, Ethyl Corp., 1411 Fourth Ave. Building, Seattle 1, Wash.

• **Oregon**
C. A. Dillinger, Tokheim Pump Agency, 1132 N.W. Glison, Portland 9, Ore.

• **Philadelphia**
P. H. Paul, Autocar Co., Ardmore, Pa.

• **Pittsburgh**
W. J. Kittredge, Jr., 3701 Liberty Ave., Pittsburgh, Pa.

• **St. Louis**
W. E. Lang, 6523 Nottingham Ave., St. Louis 9, Mo.

• **San Diego**
D. R. Thomas, 702 Wrelton Drive, San Diego 9, Calif.

• **Southern California**
Frank Radovich, California Testing Laboratories, Inc., 1429 Santa Fe Ave., Los Angeles 21, Calif.

• **Southern New England**
C. O. Broders, Pratt & Whitney Aircraft Division, United Aircraft Corp., 400 Main St., E. Hartford 8, Conn.

• **Spokane-Intermountain**
W. B. Keith, S. 303 E St., Spokane 9, Wash.

• **Syracuse**
C. R. Armbrust, Easy Washing Machine Corp., Spencer & Solar Sts., Syracuse 1, N. Y.

• **Texas**
J. T. Wade, Texas Power & Light Co., Interurban Building, Dallas, Tex.

• **Twin City**
F. A. Donaldson, Donaldson Co., Inc., 666 Pelham Blvd., St. Paul 4, Minn.

• **Virginia**
J. D. Lawrence, P.O. Box 1658, Richmond 13, Va.

• **Washington**
H. A. Roberts, Roberts Brothers Co., 17th & U Sts., NW, Washington 9, D. C.

• **Western Michigan**
W. R. Johnson, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.

• **Wichita**
M. J. Gordon, Beech Aircraft Corp., Wichita 1, Kans.

GROUPS

• **British Columbia**
Burdette Trout, Truck Parts & Equipment, Ltd., 1095 Homer St., Vancouver, B. C.

• **Colorado**
R. S. Arnold, Arn-Wood Co., 610 W. Colfax, Denver 4, Colo.

• **Mohawk-Hudson**
E. I. Billings, Socony-Vacuum Oil Co., Inc., P.O. Box 1149, Albany 1, N. Y.

• **Salt Lake**
F. G. Backman, Midwest Serv. & Supply Co., 1333 S. Main St., Salt Lake City 4, Utah.

• **Williamsport**
R. S. Wilson, Lycoming Division, AVco Mfg. Corp., Oliver St., Williamsport 38, Pa.

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